Sex Chromosome Translocation and Speciation:

A Drosophila Genetic Model

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ABSTRACT

Although exceptions may be readily identified, two generalizations concerning genetic differences among species may be drawn from the available allozyme and chromosome data. First, structural gene differences among species vary widely. In many cases, species pairs do not differ more than intraspecific populations. This suggests that either very few or no gene substitutions are required to produce barriers to reproduction (Avise 1976). Second, chromosome form and/or number differs among even closely related species (White 1963; 1978; Fredga 1977; Wright 1970). Many of the observed chromosomal differences involve translocational rearrangements; these produce severe fitness depression in heterozygotes and were, thus, long considered unlikely candidates for the fixation required of genetic changes leading to speciation (Wright 1977). Nonetheless, the fact that species differences are frequently translocational argues convincingly for their fixation despite prejudices to the contrary.

Haldane's rule states that in the F_1 of interspecific crosses, the heterogametic sex is absent or sterile in the preponderance of cases (Haldane 1932). This rule definitely applies in the genus Drosophila (Ehrman 1962). Sex chromosome translocations do not impose a fitness depression as severe as that imposed by autosomal translocations, and X-Y translocations may account for Haldane's rule (Haldane 1932). Consequently a study of the fit-

ness parameters of an $X \cdot Y^L$ and a Y^S chromosome in Drosophila melanogaster populations was initiated by Tracey (1972). Preliminary results suggested that $X \cdot Y^L // Y^S$ males enjoyed a mating advantage with $X \cdot Y^L // X \cdot Y^L$ females, that this advantage was frequency dependent, that the translocation produced sexual isolation and that interactions between the Y^L, Y^S and a yellow marker contributed to the observed isolation (Tracey and Espinet 1976; Espinet and Tracey 1976). Encouraged by the results of these prelimimary studies, further experiments were performed to clarify the genetic nature of the observed sexual isolation, the reality of the Y^S frequency dependent fitness and the behavioural changes, if any, produced by the translocation. The results of this work are reported herein.

Although the marker genes used in earlier studies, sparkling poliert and yellow have both been found to affect activity,but only yellow effects asymmetric sexual isolation. In addition yellow effects isolation through an interaction with the T(X-Y) chromosomes, Y^S also effects isolation, and translocational strains are isolated from those of normal karyotype in the absence of marker gene differences. When Y^S chromosomes are in competition with Y chromosomes on an $X \cdot Y^L$ background, Y^S males are at a distinct advantage only when their frequency is less than 97%. The sex chromosome translocation alters the normal courtship pattern by the incorporation of circling between vibration and licking in the male repertoire. Finally a model of speciation base on the fixation of this sex chromosome translocation in a geographically isolated gene pool is proposed.

To

Martin L. Tracey Jr.

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"To the extent that this world surrenders its richness and diversity, it surrenders its poetry. To the extent that it relinquishes its capacity to surprise, it relinquishes its magic. To the extent that it loses its ability to tolerate ridiculous and even dangerous exceptions, it loses its grace. As its options (no matter how absurd or unlikely) diminish, so do its chances for the future."

Tom Robbins

Even cowgirls get the blues

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INTRODUCTION

Darwin's theory of natural selection was formulated without any knowledge of the laws of Mendelian hereditary. Nonetheless, he did appreciate the importance of a mechanism of inheritance which simultaneously allowed for faithful reproduction and variability. Indeed, Chapter I "Variation Under Domestication" of the Origin of Species is an elegant predictive account of the relative importance of mutation, selection and coadaptation (Darwin 1859). Darwin was quite aware that the origin of irreversible discontinuities with entirely new potentialities, is the most important single event in evolution; this is speciation.

An understanding of the causes and mechanisms of evolutionary changes and their role and relative importance in speciation has always been of tremendous interest to evolutionists. In the Linnean era, distinctness, sharp delimitation and constancy of species were stressed. Curiously, this same stability was used as the crux of the antievolutionists' argument. Descent with modification, then, could only be proven if evolutionists demonstrated that one species was actually generated from another. Even Darwin failed to demonstrate this splitting (Mayr 1963).

Much of the controversy surrounding the subject stems from the lack of the use of a constant definition of the term "species"; the unwillingness to accept a single mode of speciation; the use of the term "isolation" to mean reproductive isolation and spatial isolation, and the lack of information on the genetic structure of populations. Darwin used the term to refer to a set of individuals closely resembling each other (Mayr 1963).

Ray's 1686 definition, although basically morphological, held some notion of the modern biological species concept, in that it considered their reproductive compatibility. Koelreuter too maintained that individuals belonging to a species are those able to produce fertile offspring. Thus, cross fertility was long ago accepted by some authorities as the decisive species criterion (Mayr 1963).

In answer to "how does one population split into two non-cross fertile ones?", the proponents of allopatry, led by Moritz Wagner, 1847-1887, theorized that only spatial separation could act as an efficient barrier to the blending of varieties, and in so doing permit the gradual divergence in morphology and physiology, which would prevent fusion with the progenitor population. Darwin, although he had ample opportunity to witness the effects of isolation at work while on the Beagle, maintained that major evolutionary change was attributable to the selective accumulation of differences between populations. Yet, he held spatial isolation as playing a significant role, but "believed that many perfectly defined species have formed on strictly continuous areas" (Darwin 1872 cf. Mayr 1976). Even in such early times the many similar, but ecologically slightly different incipient species were apparent to some and were the basis of the strongest objections to universal allopatry.

Darwin, envisioned selection pressures increasing the diversity of populations, yet struggled with the belief that it would clearly be advantageous to incipient species if they were kept from blending. He toyed with the drastic differences so often observed between reciprocal crosses (for instance ♂ A x ♀ B ⟶ fertile progeny; ♂ B x ♀ A ⟶ progeny sterile or partially sterile), and was unable to explain it by natural selection.

"Nature never made species mutually sterile by natural selection nor will men" (Darwin 1903).

Following the rediscovery of Mendelism in the 1900's, a new dispute arose. Early mendelians such as DeVries theorized that species arose by mutation, and that speciation was based in sports. They subscribed to the view that natural selection generally acted to purify the gene pool by the elimination of disadvantageous mutations; that species were basically homozygous, and speciation involved a major beneficial mutational change which became fixed in populations. Drosophila work in Morgan's laboratory interpreted gross mutation as the cause of Darwin's variation. For these early mendelians, speciation was not centred in the gene frequency changes in populations.

The genetical explanation of natural selection or the restoration of Darwinian natural selection began in the 1910's and 20's with the work of Fisher (1958), Haldane (1932) and Wright (1968, 1969, 1977). These mathematical formulations of Darwinian selection have been lumped together and misunderstood by many, if not most, biologists because of their mathematical elegance (Wright 1977). They are not equivalent theories and they are definitely not single gene models of Morgan's classical theory of evolution. Although much confusion still exists with regard to the mathematical models, the modern synthetic theory was born in a widely understandable format with the publication of Dobzhansky's Genetics and the Origin of Species (1937). He summarized the mathematical models of population genetics, provided examples of genetic variations within and between species, classified the mechanisms that isolate species, and destroyed the hopeful monster theories of speciation by macromutation.

One unfortunate effect of Dobzhansky's seminal book has been a neglect of chromosomal abberations as the genetic raw material for speciation; his refutation of the macromutationists was perhaps too convincing. Fortunately, the karyotype differences between species are presently well known (Dobzhansky 1941; Stebbins 1950; White 1978). The great frequency of translocation differences between species and the possibility that these rearrangements may alter genetic control mechanisms through position effects has stimulated interest in re-examination of translocation mediated speciation; a hypothesis which had intrigued Dobzhansky since 1941, and especially during the last months of his life (Ayala 1976a).

Four basically different genetic processes, occurring in higher organisms, are recognized as conceivably playing important roles in speciation. They are:

1. Single locus allelic changes resulting in amino acid substitution in polypeptide chains.
2. Duplication in genetic structrual loci.
3. Changes in number, size and locations of blocks of heterochromatinized DNA.
4. Chromosomal rearrangements, including inversion and translocations (White 1978).

Data, relating to the first type of genetic change that might play an important evolutionary role were generated in attempts to estimate extent of genetic polymorphism in natural populations. The mean heterozygosity per gene locus in species of Drosophila, rodents, man and the horseshoe crab was found to range from 0 to 20% with the proportion of polymorphic loci ranging from 0 to 86% (Lewontin 1973). Use of electrophoretic data to characterize

populations in various stages of speciation assumes that genetic differentiation during speciation is based on the differential accumulation of variation in isolated gene pools. This variation is assumed to be reflected in the degree of protein polymorphism in populations. An extensive study of genetic differentiation during speciation, was carried out by Ayala *et al.*(1974); these studies, carried out on the *Drosophila willistoni* group, suggest that geographic populations share more than 90% similar allozymes. Populations in the process of speciation show allozyme identity indices of 0.75, 0.79, 0.5 and 0.35 for sub, semi, sibling and non-sibling species, respectively. This suggests that a substantial amount of genetic differentiation has taken place during the evolution of populations to the level of subspecies, but that there is essentially no detectable change in the structural genes in achieving complete reproductive isolation (semi species level). Interestingly, the sterility barriers separating the subspecies *D. p. pseudoobscura* and *D. p. bogotana* (Dobzhansky 1941) are very similar to those separating *D. w. quechua* and *D. w. willistoni* (Ayala and Tracey 1973). However, studies carried out by Zouros (1973) employing two morphologically distinguishable *D. mojavensis* subspecies, indicate less genetic divergence than subspecies in the *willistoni* and *pseudoobscura* groups. In addition, although *D. mojavensis* and *D. arizonensis* are considered full sibling species, only heterogametic hybrids from the cross *D. mojavensis* male x *D. arizonensis* female are sterile. Thus, these sibling species are very similar to *willistoni* subspecies. In another pair of the repleta group, *D. mulleri* and *D. aldrichi* the mean genetic distance is a mere 0.124, yet hybrid crosses result in either no progeny or all sterile progeny.

Thus, it is difficult to draw general conclusions within the genus Drosophila about the correlation of variation in structural genes and the event speciation. Nonetheless, generalized patterns may be, cautiously, suggested. Structural gene modification is greatest during differentiation from geographic populations to the level of subspecies. Once reproductive isolation has been achieved, little structural gene differentiation takes place in attaining the level of full species. In contrast, similar electrophoretic studies in the genus Peromyscus (Avise, 1976; Zimmerman, Kilpatric and Hart 1978) suggest that most of the structural gene modification occurred after partial reproductive isolation had been achieved. Investigations of the degree of genetic differentiation between chromosomally different populations of the actively speciating fossorial mole male Spalax ehrenbergi, found that genic divergence is low and genic similarity is high, I = 0.978, from tests involving 17 loci (Nevo and Shaw 1972). Studies involving eight additional loci reinforced earlier conclusions (Nevo and Cleve 1978). Further, in the fossorial rodent complexes of Thomomys talpoides, a congruent situation exists, with I = 0.925 (Nevo et al. 1974). These examples represent enlightening cases of speciation with very few genic changes. It should be noted that the degree of protein polymorphism appears to vary with function (Gillespie and Kojima 1968); this may account for some of the discrepancies among studies.

Perhaps proteins used in current allozyme studies have little or no direct bearing on speciation. So, in many cases the estimated genetic divergence between sepcies is a result of post-speciation divergence, and indices of identity and divergence give information on genetic variation, not bringing about speciation as such, but in animals long passed through

the critical gate of speciation (Bush 1975, Carson 1976, Nevo and Cleve 1978). This proposal is supported by genetic similarity indices obtained for the morphologically diverse and undoubtedly different species of pup fish (Cyprinodon). Five species of this genus differ remarkably in shape, dentition, size, scalation, ethology and ecology but genetically are very similar. Genetic similarity indices range from 0.86 to 0.97 (Turner 1974 cf White 1978). An analogous situation exists between man and chimpanzee, the genetic similarity index between which, places these obviously different species as close genetically as the morphologically indistinguishable sibling species of Drosophila (King and Wilson 1975).

Thus, electrophoretic studies, estimating the structural gene variation over various taxonomic levels have provided a partial answer to the question, what genetic variation accompanies speciation. They do not, however, answer the question "what is the character of the genetic variation between species that initiate their divergence?" From estimates of structural gene variation we find no demonstrable cause and effect relationship between the amount of structural gene modification and the event, speciation.

The second type of genetic change potentially involved in speciation, gene duplication, also provides potential material for adaptive radiation. Duplications in structural gene loci are suggested to occur by tandem duplication or unequal crossing over (Hinegardener 1976). Once duplicated, a change of base sequence in one of the copies may occur with little or no loss of fitness to its bearer. The implication is that secondary DNA may slowly and selectively be incorporated into the primary DNA, allowing the organism to broaden its niche. For example, trypsin, chymotripsin and elastase are products of gene duplication (Shotton and Hartley 1970), as

are the haemoglobins and myoglobin (Zuckerkandl 1965). There is very little information on duplication differences among populations at various degrees of divergence; nor are there examples of duplication induced mating barriers. Where such duplications do not result in sexual or other form of reproductive isolation between duplicated and ancestral forms, the evolutionary change is anagenic.

Changes in the amount of DNA, without any change in the amount of satellite DNA are still mechanistically unexplained. One case was discovered by Keyl (1965) in Chironomus thummi and C. piger. Some polytene bands of C. thummi, contain two, four, eight or sixteen times the amount of DNA as C. piger, and the inverse situation is never true. C. thummi is specifically distinct from C. piger, which appears to be the progenitor species. Similarly, in the genus Gymnopais, there are two diploid species holopticus and dichopticus, G. dichopticus appears to have been derived by the duplication, quadruplication etc. of 28 polytene bands from G. halopticus. The Keyl phenomenon may be viewed as a special type of chromosomal rearrangement that may be correlated with cladogenic evolution. The mechanism of such gene reduplication is as yet uncertain, as is the answer to the question, "does the reduplication initiate speciation?" (Keyl 1965 cf. White 1978).

The third genetic process that occurs in the evolution of higher organisms is alteration in blocks of heterochromatin. Heterochromatin does not appear necessary for the normal metabolic function or organisms (Jackson 1971), yet its significance in position effects of genes is well known (Goodenough 1978; Jackson 1971; Spofford 1976). Relocation of a gene to a foreign site in the genome by chromosomal rearrangement may lead to the modification of its expression. In procaryotes such a situation is

exemplified by fusion of the lac operon in E. coli with the trp and pur E operators, whence β-galactosidase becomes insensitive to lactose, but sensitive to intracellular tryptophan and purines. Similarly, in eucaryotes duplication of the 16A segment on the X chromosome in D. melanogaster creates a B type chromosome, which in organisms bearing it gives rise to reduced ommitidia (bar eyes). A third copy of the 16A segment further reduces the number of ommitidia. Interestingly, eye size is affected only when the 16A segments are in the cis configuration.Thus, the relative position of DNA segments in the chromosomes appears to be a significant factor in eucaryotic gene control. Heterochromatin plays a major role in breakage and reunion of chromosomes (Jackson 1971; Yoon and Richardson 1977). Genes removed from their native sites by chromosomal rearrangements, are,when in their new locations, placed differentially with respect to proximity to heterochromatic blocks. Repositioning of heterochromatin next to euchromatin results in a variable effect on gene expression. For example, a rearrangement of the X chromosome that brings heterochromatin next to the wild type allele of white eye colour in D. melanogaster (R(+) and R(+)/w) gives rise to flies with red and white eye patches (for an excellent review of position effects in D. melanogaster, see Spofford 1976). The effects of heterochromatin can spread as far as 50 polytene bands (6 map units) to genes located in euchromatin such that proximal genes are affected first (Goodenough 1978).

Position effects based on proximity to heterochromatin also have far reaching effects in vertebrates and plants. In X-autosomal translocations (T(X-A)) in the mouse, the lyonization of the X chromosome spreads to the attached autosomal segment. In maize, the dissociation activator (Ds)

moves about in the genome. When in position, it produces unstable expression of contiguous genes up to five map units in either direction. This is so similar to the variegation effects of heterochromatin and gene proximity in mice and D. melanogaster, that is it tempting to equate the (Ds) locus to a heterochromatic segment (Goodenough 1978).

Therefore, it appears that heterochromatin, both facultative and constitutive has regulatory properties once breakage has occurred. However, the mechanism is as yet not clearly understood. In any event, the size and distribution of the constitutive heterochromatic segments usually characterize the karyotypes of closely related species of Drosophila (White 1978; Yoon and Richardson 1978). Descriptions of the distribution of heterochromatic segments among organisms as appeared in the early literature are based on underestimations (White 1978). White's review of chromosomal differences between species lends justifiable significance to changes in heterochromatic sections playing significant roles in the process of speciation. Closely related species in the Drosophila, Acrididae (grasshoppers) and Cimex (bed bugs) although apparently homosequential in the euchromatic segments of their chromosomes differ in their heterochrome blocks. Variation in amounts and distribution of heterochromatin between species also occurs in Dipodomys crepsis (compositae) and Trillium (Liliaceae). The extent of differential rearrangement of blocks of heterochromatin identifiable between species depends on the type of karyology employed in cytogenetic studies. Therefore, it is not difficult to imagine the masking of some smaller rearrangements that perhaps characterise incipient species.

Implications for chromosomal rearrangements playing significant and critical roles in initiating the processes of speciation are frequent (see

Gottlieb 1973, 1976 and Stebbins 1970 for review in plants and Nevo 1972, 1974; Tracey and Espinet 1976; White 1978; Zimmerman et al. 1978 and Fredga 1977 for examples of animal studies). White's (1978) review provides evidence suggestive of 98 percent of all speciation events are accompanied by chromosomal rearrangements, and such rearrangements, particularly those involving the sex determining mechanisms, playing primary roles in initiating divergence leading to speciation.

Of the reproductive isolating mechanisms documented by Dobzhansky (1937), two, sexual isolation and hybrid sterility, are often observed in an asymmetric condition in natural populations. In interspecific crosses, sexual isolation may be observed in one direction, but not in the other (Ohta 1978). In addition, heterogametic hybrid sterility may be observed from interspecific crosses made in one direction and not in the other (Darwin 1903, Dobzhansky 1941, 1974, Ehrman 1962, Haldane 1932, Stern 1929).

In an attempt to explain hybrid sterility in the heterogametic sex, Haldane (1932) suggested that sex chromosome translocations may be the cause, a hypothesis which Stern (1929) had demonstrated as workable. Fixation probabilities of sex chromosome translocations ($X \cdot Y^L$ and Y^S) were estimated by Tracey (1972). These were found to exceed those expected under the hypothesis of no selection. In addition, $X \cdot Y^L // Y^S$ males enjoyed a mating advantage over $X \cdot Y^L // Y$ males and Y^S fixation appeared to be frequency dependent.

The fitness of X//Y males relative to $X \cdot Y^L // Y$ males appeared to depend on the female state of the population. X//Y fitness being highest when females were X//X and lowest when females were homozygous for the $X \cdot Y^L$ chromosome.

The mating advantage enjoyed by $X \cdot Y^L // Y^S$ males over $X \cdot Y^L // Y$ males when females were $X \cdot Y^L // X \cdot Y^L$, was demonstrated by Tracey and Espinet (1976) to be based primarily in the presence of the Y^S chromosome. $X \cdot Y^L$ and yellow interactions with the Y^S accounts for the rest of the advantage. In addition, a position effect involving yellow and X-Y translocation was observed (Espinet and Tracey 1976; Tracey and Espinet 1977). $\underline{Y}^+$ males enjoyed a mating advantage except where the $\underline{y}^+$ was borne on an X and the Y chromosome was Y^S. When the $\underline{y}^+$ is Y^S-borne, there was a Y^S, $\underline{y}^+$ mating advantage, as there was in Y-bearing males when the $\underline{y}^+$ was X-borne.

Further, we found significant sexual isolation between T(X-Y) yellow stocks and a karyotypically normal $\underline{y}^+$ strain, marked with sparkling poliert (Tracey and Espinet 1976). These preliminary results were exciting as sexual isolation between sex chromosome translocation stocks and normal karyotype stocks of a value in excess of that found by Ayala and Tracey (1973) for subspecies of Drosophila willistoni and within the semi species range for D. paulistorum appeared to require little or no genic substitution. Haldane's explanation of reproductive isolation appeared to be supported. A sex chromosome translocation, then, appeared to result simultaneously in sterility in the hybrid heterogametic sex and sexual isolation in D. melanogaster during a process in the laboratory that closely resembles the initial stages of speciation in the field.

This system was worth further study as an animal model of sex chromosome translocation based speciation. Studies of wild populations and their allozyme, duplication, heterochromatin or rearrangement differences are necessary. They are not sufficient. As Sewall Wright noted nearly forty years ago (Wright 1940):

> The first step in applying genetics to the problem [of speciation] is undoubtedly the discovery of the actual nature of the genetic differences among allied subspecies, species and genera in a large number of representative cases. ... But even if we had a complete account of the genetic differences within a group of allied species, we would not necessarily have much understanding of the process by which the situation had arisen.

Much later he wrote (Wright 1977):

> It is necessary to conclude from the extreme rarity of translocations within species, but great frequency of such differences between closely related ones, that a large proportion of species have their origins in the partial reproductive isolation provided by the fixation of a translocation in a very small colony.
>
> Multiple selective peak shifts are especially likely to have been established in the proportion of the range of the parent species within which a translocation becomes fixed and also during the early history of the new species while still broken up into small transient colonies, since the fetilized females that start new colonies are likely to come from the more successful ones.
>
> This situation gives rise to a curious similarity of the course of evolution from the shifting balance process to that supposed to occur under de Vries' mutation theory. In both cases there would be an association between the "chromosome repatternings" of Goldschmidt that provide the basis for reproductive isolation, and for the major phenotypic steps. Goldschmidt supposed that these were two aspects of the same event, while under the view taken here, they merely tend to be associated because both are favored by the same level situation.

Our preliminary report (Tracey and Espinet 1976) suggested, as is so often the case, that Wright and Goldschmidt's views were both partially applicable. Asymmetric reproductive isolation is definitely consequent upon $X \cdot Y^L$ and Y^S fixation. Moreover, it appeared that the T(X-Y) flies exhibited sexual isolation. However, conclusive tests of the degree of sexual isolation attributable to the translocation and the yellow marker necessitates homogenization of stock genetic background.

1. Consequently, experiments are presented below which were run to evaluate the sexual isolation based on the yellow allele, the sparkling poliert marker, the sex chromosome translocation, the combination of yellow and the sex chromosome translocation, and various combinations of the sex chromosome karyotype, body colour marker and eye mutation.

2. The $X \cdot Y^L // Y^S$ male mating advantage over $X \cdot Y^L // Y$ males with $X \cdot Y^L // X \cdot Y^L$ females appeared to be mainly attributable to the Y^S (Tracey and Espinet 1976). The fitness advantage of X//Y males varied with female state; it was highest when females were X//X (Tracey 1971). Therefore experiments were carried out to investigate the dominance-recessive relationship of X versus $X \cdot Y^L$ chromosomes with respect to female acceptance patterns.

3. Inbred Amherst Drosophila melanogaster fed on α-dimethyl tyrosine were reported to have emerged as yellow phenocopies at a rate proportional to dosage (Burnet, Connolly and Harrison 1973). Phencopied flies were reported to behave as yellow mutants during courtship. Thus, in order to further study the effect of yellow on mating frequency, phenocopying of T(X-Y), y^+ and Amherst flies was attempted.

4. Further experiments were run to test the frequency dependence hypothesis of Y^S chromosome fitness and fixation in populations where the Y-chromosomes are Y^S and Y.

5. Differential mating success was observed among T(X-Y) and X-Y males (Tracey and Espinet 1976). Manning (1965) has reported differences in the most frequent sequences in the elements of courtship behaviour of two groups of closely related species of Drosophila, D. melanogaster, D. simulans and D. takahashii, and D. aurania, rufa and montium. In an attempt to detect stock specific differences in mating behaviour, mating sequences were examined.

MATERIALS AND METHODS

Stocks: Experimental Drosophila melanogaster stocks identified by their male genotypes are listed in Table 1. Stocks 1, 2, 7 and 9 were the foundation lines used in these studies. The wild stock (stock 1) was obtained from Brian Dempsey (Dempsey, 1976; Tracey and Dempsey 1979). The sparkling poliert stock (stock 2) was obtained from Dr. James F. Kidwell, Brown University, Providence, Rhode Island. The X-Y translocation stocks have been previously described (Tracey and Espinet 1976). T(X-Y)y^+ (stock 9) was originally obtained from Dr. Irwin Oster (Tracey 1972). All other stocks were synthesized from these basic strains.

Initially the three mutant stocks (2, 7 and 9) were homogenized by outcrossing to the wild strain (1) in order to restore wild type variation that was perhaps inadvertently lost through laboratory culturing. The scheme followed in this outcrossing/homogenizing step is illustrated in Appendix A, Figure A1.

The translocation stocks T(X-Y)y and y^+ (stocks 7 and 9), were then similarly homogenized against sparkling poliert (stock 2). Stocks 3, 8 and 10 of Table 1 were synthesized from progeny derived from this latter homogenization. The scheme followed in the homogenization and synthesis is illustrated in Appendix A, Figure A2.

To produce stock 4 (X•y^+//Y) double crossover progeny, y^+ f car•, were recovered from crosses between F_1 females (Appendix A, Figure A1, Step II), and X•Y^L//Y males (Tracey and Espinet 1976). Double homozygous crossover chromosomes were produced by F_1 intercrossing and identified by sterility of X•y^+//Y^S males (see Appendix A, Figure A3).

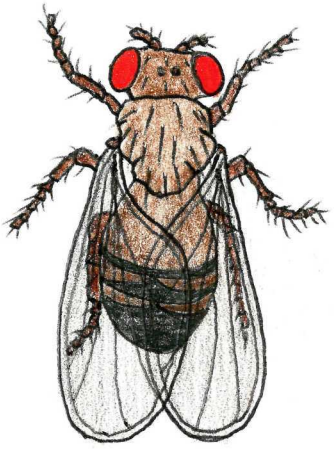
Table 1. List of laboratory stocks of *Drosophila melanogaster* used in studies reported below. All stocks were derived from four basic ones: (1) A wild strain, Randy (Dempsey 1976; Dempsey and Tracey 1979) with sex chromosomes and mutations similar to stock 1; (2) A *sparkling poliert* strain (M. Kidwell, Brown University, Rhode Island) marked as stock 2; and (3 and 4) Two X-Y translocation stocks (Espinet 1976; Tracey and Espinet 1976) with sex chromosomes identical to stocks 7 and 9. Derivative crossing schemes for synthesis and homogenization of stocks listed below are given in Appendix A. Sex chromosome karyotypes, marker mutations, their chromosomal location, and phenotypes of each experimental stock are recorded.

Stock	Sex Chromosome		Mutations			Phenotype
	Female	Male	X	Y	Autosome	
1.	X//X	X//Y				wild
2.	X//X	X//Y			*spa*^{pol}	*sparkling poliert*
3.	X//X	X//Y	*y*		*spa*^{pol}	*yellow*, *sparkling poliert*
4.	X•//X•	X•//Y	*f car*			*forked*, *carnation*
5.	X•//X•	X•//Y	*y f car*			*yellow*, *forked*, *carnation*
6.	X•Y^{L}//X•Y^{L}	X•Y^{L}//Y	*y f car*			*yellow*, *forked*, *carnation*
7.	X•Y^{L}//X•Y^{L}	X•Y^{L}//Y^{S}	*y f car*			*yellow*, *forked*, *carnation*
8.	X•Y^{L}//X•Y^{L}	X•Y^{L}//Y^{S}	*y f car*		*spa*^{pol}	*yellow*, *forked*, *sparkling poliert*
9.	X•Y^{L}//X•Y^{L}	X•Y^{L}//Y^{S}	*y f car*	y^{+}		*yellow/wild*, *forked*, *carnation*
10.	X•Y^{L}//X•Y^{L}	X•Y^{L}//Y^{S}	*y f car*	y^{+}	*spa*^{pol}	*yellow/wild*, *forked*, *sparkling poliert*

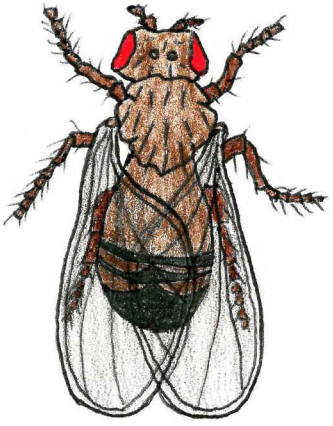
Stock 5 (X·//Y) was produced from single crossover progeny, y f car·, recovered from F_1 females ($X \cdot Y^L//X$) back crossed to wild males (X//Y) (see Appendix A, Figure A4). To produce stock 6 ($X \cdot Y^L//Y$), females from stocks 7 and 9 ($X \cdot Y^L//X \cdot Y^L$) were crossed to $X \cdot Y^L//Y$ males (see Appendix A, Figure A5). Phenotypes of experimental stocks are given in Figure 1.

Culture Conditions: Flies were reared on a cream of wheat-molasses mixture, containing tegosept and seeded with live yeast (Fleischmann's). (See Appendix A, Table A1 for medium contents.) Stocks were cultured in 3 x 10 cm vials and held at room temperature (22°-26°C).

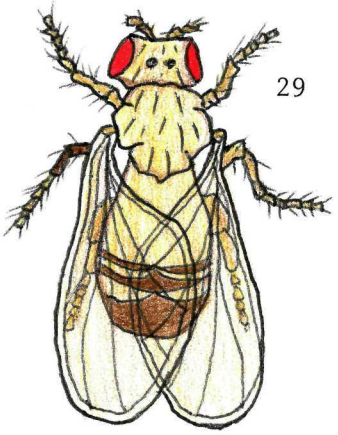
Mating Chamber Studies: Experiments to observe the homogametic and heterogametic mating frequencies were carried out in 16.5 x 16.5 x 2.5 cm plexiglass chambers with slope-sided, circular arenas having top and bottom diameters of 13.5 and 11.3 respectively, and a depth of 1.2 cm. These were floored with water-moistened filter paper (see Figure 2). Virgin females and naive males less than eight hours old were collected from each stock and held separated by sex and karyotype for a period of four to nine days. Older flies were used preferentially in testing as they courted more rapidly. Replicate runs of the same comparison were carried out in used chambers, as flies courted and mated in used chambers faster and more frequently than in fresh ones (Ehrman per. comm.; Espinet 1976). Where stocks were phenotypically identical, they were rendered distinguishable by reciprocal clipping of their wing tips. The possibility exists that mating success is influenced by wing clipping; however, notching of the wings has been reported to have no effect on mating success (Ehrman 1966, Markow et al.1978). This observation has been confirmed for the flies used in these studies (Espinet 1976). Clipping was carried out when the flies were initially etherized; they were allowed approximately four days to recover from etherization



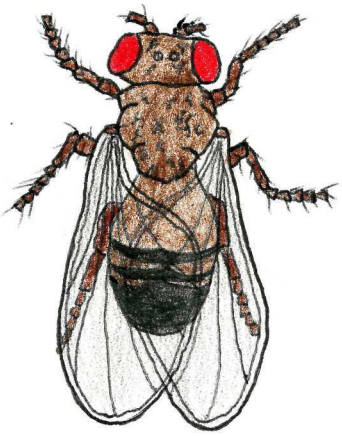
X//Y, (1)
y^+, f^+ spa^{pol+}



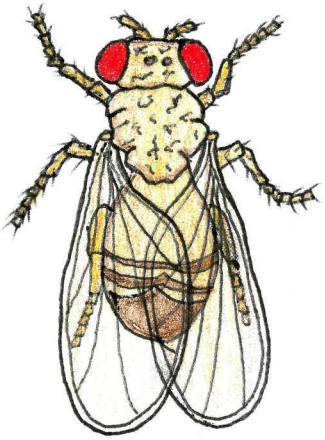
X//Y, (2)
y^+, f^+, spa^{pol}



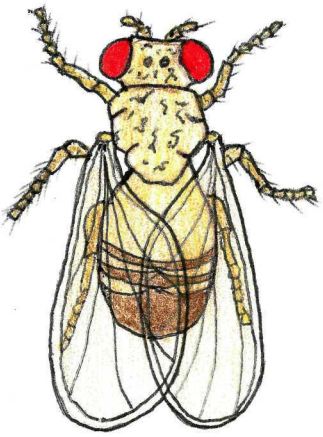
X//Y, (3)
y, f^+, spa^{pol}



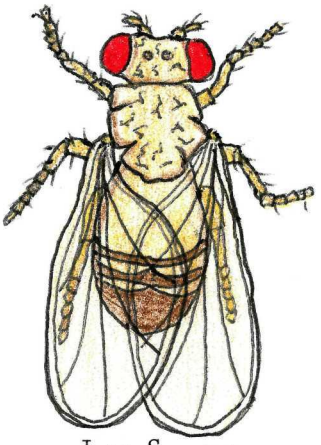
X•//Y, (4)
y^+, f, spa^{pol+}



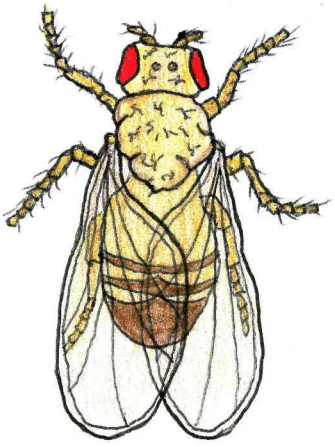
X•//Y, (5)
y, f, spa^{pol+}



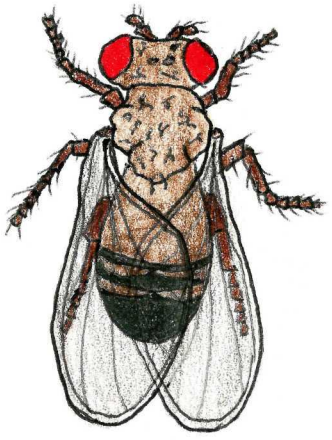
$X•Y^L//Y$, (6)
y, f, spa^{pol+}



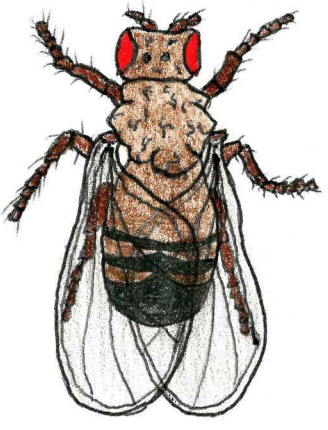
$X•Y^L//Y^S$, (7)
y, f, spa^{pol+}



$X•Y^L//Y^S$, (8)
y, f, spa^{pol}



$X•Y^L//Y^S$, (9)
y^+, f, spa^{pol+}



$X•Y^L//Y^S$, (10)
y^+, f, spa^{pol}

Figure 1. Male karyotypes and phenotypes of experimental stocks. Stock numbers are given in parentheses following the karyotypes (see Table 1).

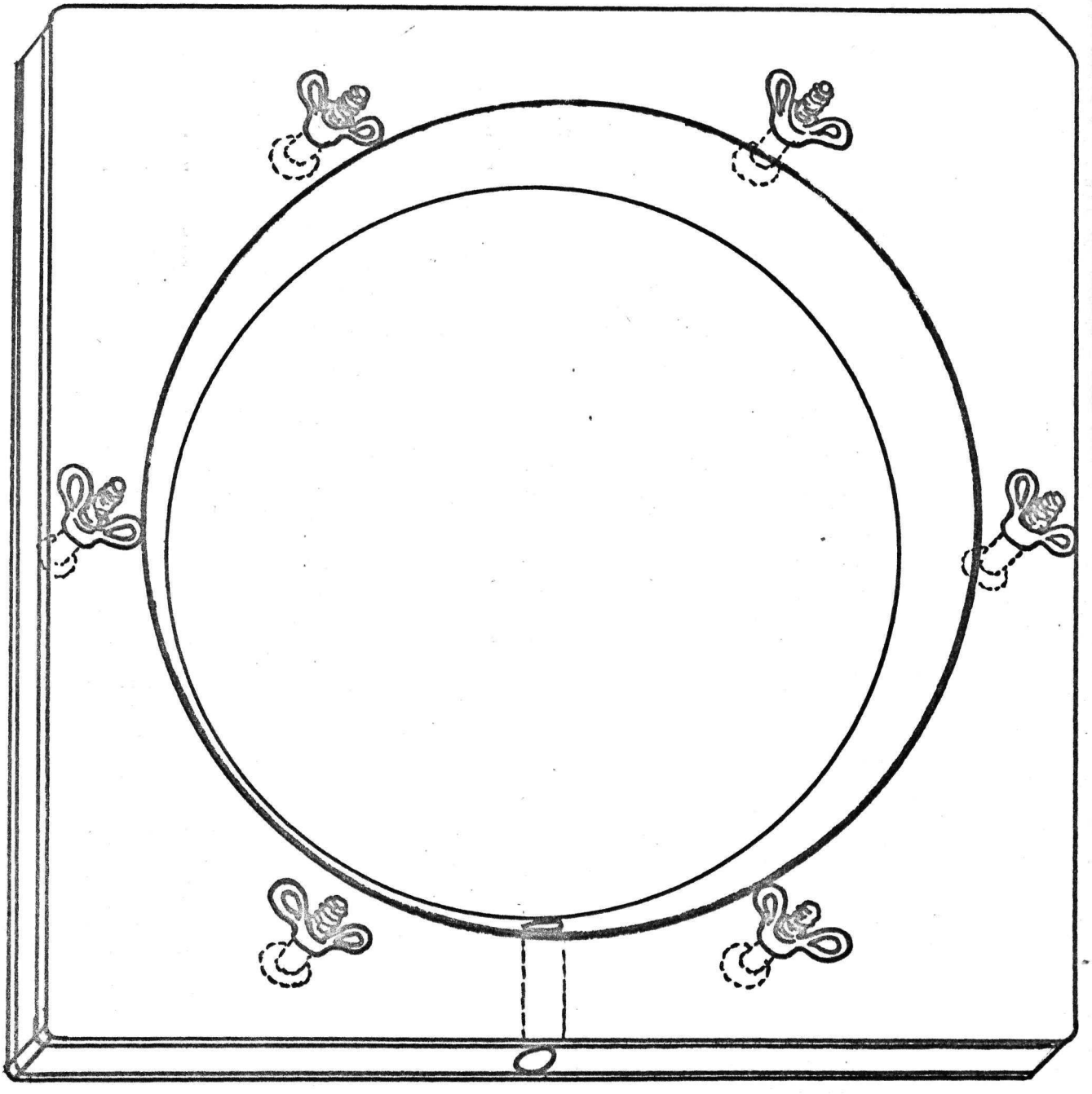


Figure 2. Type of mating observation chambers used in sexual isolation experiments (see Materials and Methods). Magnification: actual area x 1 inch.

and clipping. Twelve males and 12 females from each stock used in a particular study were aspirated unetherized, females first, into the mating chamber. Homokaryotypic and heterokaryotypic (gametic) mating frequencies were directly observed and recorded (see Appendix B: Data Sheets). Chambers were continuously observed for the first hour, and intermittently thereafter, as 80 to 90 percent of the matings that occurred in each chamber took place in the first hour. Copulation events were scored, and a single point was awarded to a genotypic team each time members of that team were observed mating. In this method, the same pair mating twice secures two points for their team. Similarly, the same male mating with two similar females secures two points for his genotypic team.[1]

Mating chambers fell into three categories: multiple choice, where each individual has a choice of two different types of mates; male choice, where each male had two types of females available to him while each female could choose only to mate or not to mate; and female choice, where females were offered a choice of two different types of males but only one type of female was available.

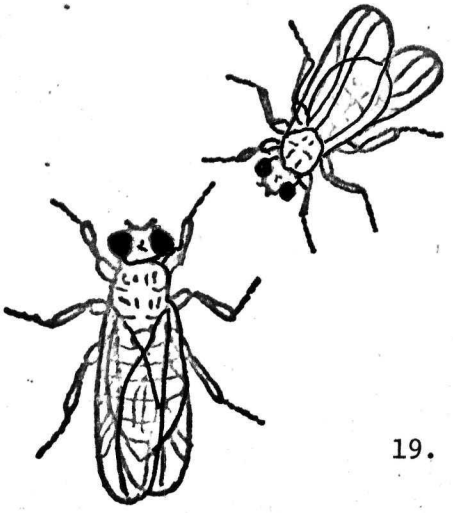
Phenocopy Experiments: Burnet, Connolly and Harrison (1973) reported that inbred Amherst Drosophila melanogaster fed on α-dimethyl tyrosine (α-DMT) in Sang's larval medium C (Sang 1956) emerged as yellow phenocopies at a rate proportional to dosage. Above a concentration of 0.15 percent α-DMT, a total lack of eclosion was observed. Phenocopied flies possessed qualities in their mating behaviour that resembled those of yellow mutants. Phenocopying T(X-Y)y^+ and Amherst Drosophila melanogaster (obtained from Dr. Margaret M. Kidwell, Brown University, Rhode Island) to eliminate the effect of y^+ on mating frequency was attempted, in order to observe the

[1]As Chi-square assumes independance, it is here noted that copulation duration wasrelatively lengthy and that multiple mating was relatively infrequent.

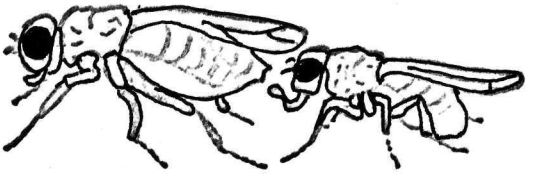
differences in mating success of individuals with and without T(X-Y) chromosomes, in the absence of the confounding effects of prior recombination.

To produce yellow phenocopies of wild Amherst and T(X-Y)y^+ flies, these stocks were cultured on Sang's larval medium C containing α-DMT (see Appendix A, Table A2 for constitutents) at concentrations of 0, 0.038, 0.075, 0.15 and 0.3 percent. Five pair homokaryotypic crosses were made in duplicate at each concentration and cultured at 25°C for 20 days. Progeny were collected after 10 days, twice a day for 10 consecutive days.

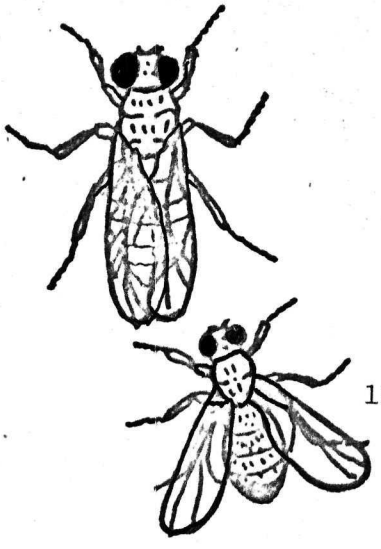
Courtship Behaviour Sequences: To test the hypothesis that the differentials in mating frequencies enjoyed by X•//Y,y^+ , $X•Y^L//Y^S y^+$ and $X•Y^L//Y^S$ males with X•//X• and $X•Y^L//X•Y^L$ females are due to a karyotype specific change in the sequence in which the elements of courtship behaviour are performed by males, single pairs of homokaryotypic, naive males and virgin females were aspirated unetherized into 6 cm diameter disposable petri dishes, which were lined with water-moistened filter paper. The flies were allowed a five minute acclimation period, after which time 20 elements of the male and female behaviour (Appendix A, Table A3, Figure 3) were recorded. Behavioural elements were recorded continuously for a period of 30 minutes or until copulation was achieved, whichever came first. Recordings were collected with the aid of a Bell telephone push-button keyboard coupled to a 20 channel Esterline-Angus event pen recorder, at chart speeds of between 3.8 and 4.0 cm per minute. The event, successful-copulation, was used to identify the sequence prior to that event as courtship behaviour. All recording sessions did not terminate in mating. In those that did, the time interval to successful-copulation varied considerably: 16.94 ± 7.45 m. The data used



19. Circling

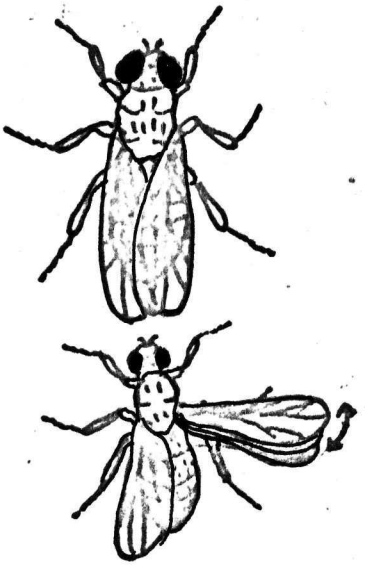


16. Licking



12. Scissoring

16. Licking and
17. Abdomen curling



15. Vibrating

(20. Attempted)
copulation

Figure3 . Some elements of the mating behaviour of Drosophila melanogaster. The numbers describing each behavioural element correspond to those given in Appendix A, Table A3.

in the analysis were those elements of behaviour, qualitatively consistent over the three karyotypes tested. The number of replicates analyzed per stock was determined by the number of matings achieved during the experimental period, by the karyotypic stock ($X\cdot//Y(y^+)$) that showed the least number of matings (two). The event frequencies and the probabilities that any event was followed by another were calculated. In so doing, the most probable sequences of performance of the elements of courtship behaviour for $X\cdot//Y(\underline{y}^+)$, $X\cdot Y^L//Y^S\underline{y}^+$ and $X\cdot Y^L//Y^S$ flies were obtained. Those sequences were then compared for sex chromosome translocation and body colour specific differences.

Population Cages: To determine the nature of the $Y\text{-}Y^S$ equilibrium state in a population where the $X\cdot Y^L$ chromosome was fixed, three 32.85 x 33.1 x 8.5 cm plexiglass cages containing thirty-six 2.75 x 5.8 cm scintillation bottles as food cups, filled with approximately 11 ml instant Drosophila media (Carolina Biological Supply) (Figure 4) were initiated at Y^S frequencies of 0.5, 0.75 and 0.99. Virgin females and naive males, collected less than eight hours after eclosion, were held separated by sex and genotype for four days. On day five, 400 unetherized flies were introduced, females first, into each cage. Mating and oviposition were allowed to continue for 48 h at 25°C in these cages. At the end of this period, parents were etherized and surviving females were individually cultured in scintillation vials to obtain isofemale progeny. Assuming that the surviving females were a random sample of those leaving progeny in the cages, mating frequencies could be scored and compared with generation one male progeny frequencies from the cages. Cages cleared of parents and containing larvae and eggs were incubated at 25°C for approximately 14 days, after which time

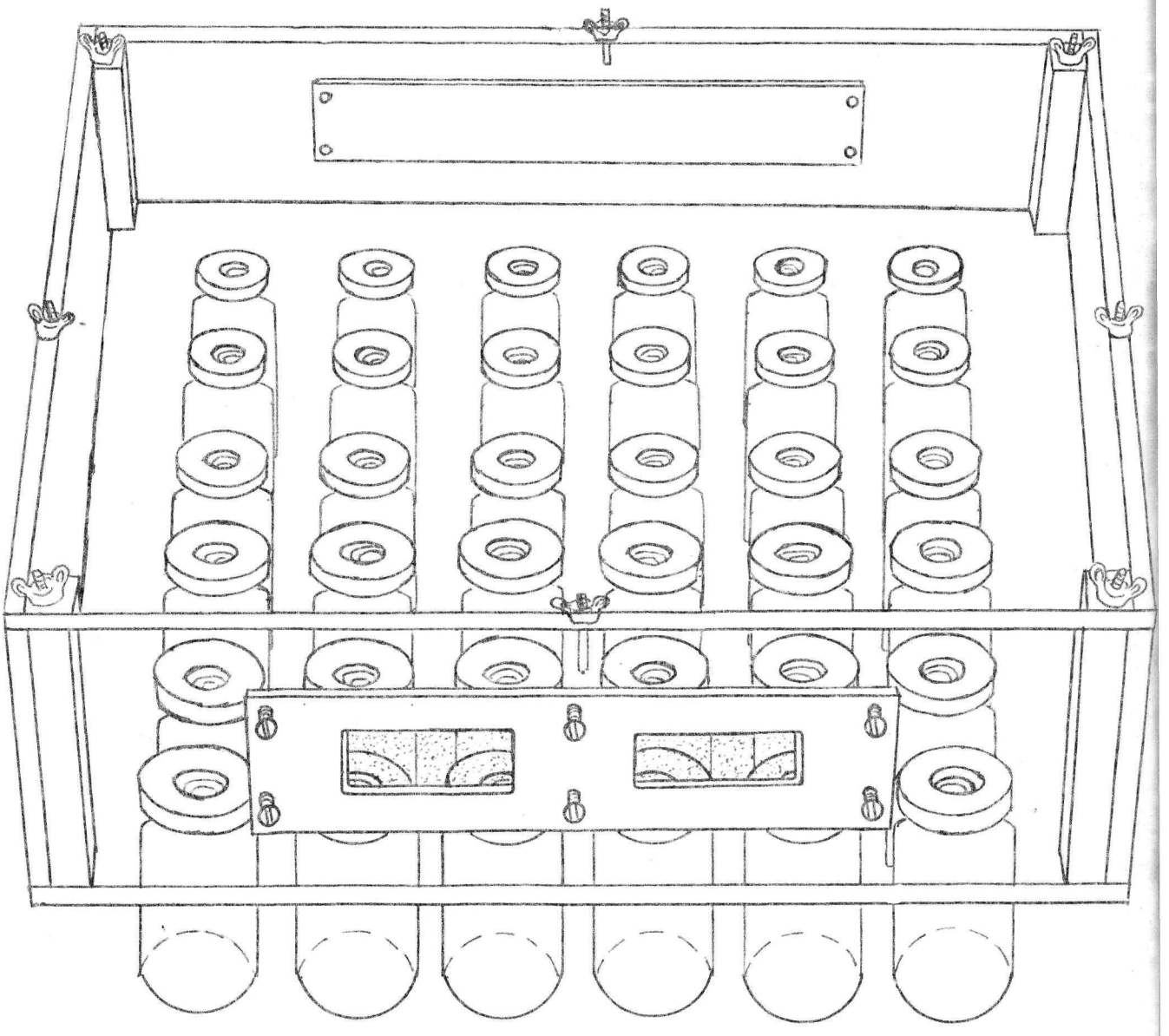


Figure 4. Type of population cage used in Y^S fitness experiments (see Materials and Methods).

eclosed progeny were etherized, scored, held until all individuals were once again active, returned to clean cages containing fresh food cups, and indubated at 25°C for 48 h. At the end of this period, all surviving adults were etherized and discarded. Two more generations were similarly maintained for cages initiated at 0.99 and 0.75 Y^S frequencies. Two generations of data were collected in the manner described above for the cage initiated at a Y^S frequency of 0.5.

RESULTS

Sexual isolation between wild and sparkling poliert flies of normal and T(X-Y) karyotypes: A preliminary study of sexual isolation between wild and $X \cdot Y^L$, Y^S karyotype flies employed wild flies marked with spa^{pol} (Tracey and Espinet 1976); significant sexual isolation was observed ($I = 0.65 \pm 0.08$). Use of the spa^{pol} allele to mark the wild flies leaves open the possibility that the observed isolation is the result of the marker gene rather than of a karyotypic effect. Consequently three sets of 2 x 2 mating chambers and one set of male choice experiments were run to assess the relative magnitude of marker and karyotypic effects on sexual isolation and mating frequency (Table 2).

The spa^{pol} marker does not affect female mating frequency as 136 spa^{pol} and 130 wild female matings were observed overall for the 2 x 2 studies. Further, no significant difference in female mating frequencies was observed in the male choice experiments; the chi-square value and its associated probability being 0.09 and 0.77, respectively (Table 2, study 4).

The marker does however, significantly reduce male success; 66 spa^{pol} and 200 wild male matings were recorded overall.

Neither contingency chi-square tests nor sexual isolation coefficients suggest that homogametic mating preference is attributable to the spa^{pol} marker, in any of these karyotypic backgrounds.

Comparisons of yellow and wild $X \cdot Y^L // Y^S$ mating frequencies: Although previous workers have reported a significant wild male mating advantage with both wild and yellow females (Bastock 1956, Threlkeld 1974), we were unable

Table 2. Mating chamber studies of sparkling^{poliert} (A) versus wild (B) mating success in wild and sex chromosome translocated stocks (T(X-Y)), in which the X·Y^L chromosome is y f car and the Y^S may be y^+. The stock source numbers (see Table 1) are recorded in parentheses for all A's and B's. Homogametic and heterogametic matings are tabulated as 2 x 2 arrays; the number of chambers run is given in parentheses following the total number of matings. Chi-square values for the contingency test, and the two goodness-of-fit tests of male and female mating equivalence are followed by their associated probabilities ($P < 0.001$)*. Levene's sexual isolation index (I) and its standard deviation (Ayala and Tracey 1973) for each test, are recorded in the last column.

	KARYOTYPE	MALES	FEMALES A	FEMALES B	TOTALS	CHI-SQUARE TESTS 2 x 2	Males	Females	I
			(8)	(7)					
1.	T(X-Y), y	A (8)	12	10	22	0.00 (1.0)	30.56 (<0.001)*	0.82 (0.40)	-0.05 ± 0.10
		B (4)	42	35	77				
		Totals	54	45	99 (5)				
			(10)	(9)					
2.	T(X-Y), y^+	A (10)	6	5	11	0.17 (0.71)	19.80(<0.001)*	0.02(0.89)	0.05 ± 0.13
		B (9)	21	23	44				
		Totals	27	28	55 (3)				
			(2)	(1)					
3.	Wild	A (2)	14	19	33	0.84 (0.39)	18.89 (<0.001)*	0.04 (0.86)	-0.07 ± 0.09
		B (1)	41	38	79				
		Totals	55	57	112(5)				
			(0)	(9)					
4.	T(X-Y), y^+	A (10)	52	49	101(5)			0.09 (0.77)	

to detect differences in mating success between yellow and wild $X{\cdot}Y^{L}//Y^{S}$ males with yellow $X{\cdot}Y^{L}//X{\cdot}Y^{L}$ females (Espinet 1976, Tracey and Espinet 1976). To test the hypothesis that the equivalencies observed in our work were the result of selective elimination of alleles predisposing females to accept wild males as mates (Threlkeld 1974), further mating chamber studies were run (see Table 3). In experiments 1, 2 and 3, females were heterozygous, one $X{\cdot}Y^{L}$ came from a wild or y^{+} bearing stock and the other $X{\cdot}Y^{L}$ came from a yellow stock. Those in experiments 9 and 10 came from a y^{+} stock. No significant male mating frequency differences were detected in any of these studies.

Significant differences were, however, observed in experiments 8 and 9. Flies in these studies had been outcrossed to a wild strain (see Materials and Methods, and Appendix A, Figure A1). Fifty percent of the females used in each of these studies belonged to a yellow stock, and fifty percent came from a y^{+} stock.

Sexual isolation between yellow and wild flies: The reduced mating success of yellow males with wild females have been established. The observed sexual isolation coefficient between T(X-Y), y and wild spa^{pol} flies (Tracey and Espinet 1976) is perhaps confounded by yellow effects. Thus, this, like the spa^{pol} marker, was checked. Experiments to evaluate the isolation resulting from y, are recorded in Table 5.

The yellow marker does not appear to affect female mating frequency, 110 y and 102 y^{+} female matings were observed. Like spa^{pol}, it does significantly reduce male mating frequency when competing y and y^{+} males bear wild karyotype X chromosomes. Fifty-three y and 126 y^{+} male matings were observed (see Table 4, experiment 1). In experiment 2, the X chromosomes are X·, and y and y^{+} males have equivalent mating frequencies.

Table 3. Yellow ($X \cdot Y^L // Y^S$) and wild ($X \cdot Y^L // Y^S$ y^+) male mating frequencies with $X \cdot Y^L // X \cdot Y^L$ y f car females. The stock source of the $X \cdot Y^L$ chromosomes is numerically indicated in column one for females, and columns two and three for yellow and wild males respectively (see Materials and Methods, Table 1). The first 7 experiments were carried out using stocks identical to those used in previous studies (Tracey and Espinet 1976). The final 2 experiments employed stocks outcrossed to a wild strain (see Appendix A, Figure A1). The X chromosomes of 50% of the males of experiment 3 and females of experiment 8 and 9, came from the stocks indicated. Yellow and wild male matings, Chi-square values (1 d.f. for 50:50 expectation) and associated probabilities are also recorded ($p < 0.001$)*

	FEMALES	MALES yellow	wild	MATINGS yellow	wild	χ^2	P
1.	7//9	7	9	40	50	1.11	0.31
2.	7//9	9	7	55	63	0.54	0.47
3.	7//9	7, 9	7, 9	33	49	3.12	0.08
4.	7//7	9	7	29	36	0.75	0.41
5.	9//9	9	7	18	23	0.61	0.45
6.	7//7	7	7	61	58	0.08	0.79
7.	9//9	9	9	70	72	0.08	0.88
8.	8//8, 10//10	8	10	111	235	44.44	<0.001*
9.	7//7, 9//9	7	9	268	362	14.03	<0.001*

Table 4. Mating chamber studies of *yellow* (A) versus wild (B) mating success where all X chromosomes lack Y^L. In the *spa*^{pol} study the X is normal. In the second study the X is X• (see Materials and Methods and Appendix A, Figures A3 and A4). The *yellow* marker and its wild allele are X-linked. The stock source for each competing population is parenthesized with the A and B headings (see Table 1). Homogametic and heterogametic matings are tabulated as 2 x 2 arrays; the number of chambers run is given in parentheses following the total number of matings. Chi-square values for the contingency tests and the two goodness-of-fit tests of male and female mating equivalence are followed by their associated probabilities ($P < 0.001$)*. Levene's sexual isolation index (I) and its standard deviation, for each test, are recorded in the last column (Ayala and Tracey 1973).

	MARKER	MALES	FEMALES A	FEMALES B	TOTALS	CHI-SQUARE TESTS 2 x 2	Males	Females	I
			(3)	(2)					
1.	*spa*^{pol}	A (3)	45	8	53	28.61 (<0.001)*	29.77 (<0.001)*	1.26 (0.27)	0.33 ± 0.07
		B (2)	52	74	126				
		Totals	97	82	179 (9)				
			(5)	(4)					
2		A (5)	10	3	13	10.45 (<0.001)*	1.48 (0.13)	0.76 (0.41)	0.58 ± 0.14
		B (4)	4	16	20				
		Totals	14	19	33 (3)				

Contingency tests show significant chi-square values, indicating discriminitive mating patterns; the sexual isolation coefficients suggest positive assortative mating attributable to the yellow allele.

Sexual isolation between T(X-Y) and wild karyotype populations of flies: Five studies of the degree of sexual isolation between T(X-Y) and X-Y flies were carried out, in order to estimate the isolation effected by the T(X-Y) karyotype. The following studies were executed (see Table 5):

1. $X\cdot Y^{L}$, Y^{S} vs X, Y where all flies were spa^{pol}, and males were y^{+} (stocks 10 and 2 of Table 1);

2. $X\cdot Y^{L}$, Y^{S} vs X, Y where all males were y^{+} (stocks 9 and 1 of Table 1);

3. $X\cdot Y^{L}$, Y^{S} vs X·, Y were all males were y^{+} (Stocks 9 and 4 of Table 1);

4. $X\cdot Y^{L}$, Y^{S} vs X, Y where all flies were spa^{pol} and y (Stocks 8 and 3: and

5. $X\cdot Y^{L}$, Y^{S} vs X·, Y where all males were y (stocks 7 and 5).

T(X-Y) females are equivalent to X//X females in mating success in $sparkling^{poliert}$, y^{+} (Study 1) and y populations (Study 4) as well as when non T(X-Y) females are X·//X·and males are y^{+} (Study 3) (see Table 5).

T(X-Y) females are at a disadvantage when males are y^{+}, and their competitors bear natural X chromosomes (Study 2). They enjoy an advantage however, when in yellow populations and their competitors bear a synthetic X(X·) (Study 5). The significant chi-square values for these two studies are 7.02 and 7.72 respectively.

In all studies where males are y^{+}, and non T(X-Y) males bear natural X chromosomes, X//Y males hold the advantage over their $X\cdot Y^{L}//Y^{S}$ counterparts. 167 and 81 X//Y and $X\cdot Y^{L}//Y^{S}$ male matings respectively were observed (Studies 1 and 2 of Table 5). However, they lose this advantage to their

Table 5. Mating chamber studies of X-Y translocation (A) versus wild chromosome (B) mating success in wild and yellow populations. The stock source (Table 1) is parenthesized under the A and B headings in the wild studies, y^+ is Y-linked in the T(X-Y) populations and X-linked in the wild karyotype ones. In the last wild and yellow study (experiments 3 and 5), the X is X• (see Materials and Methods). The presence of additional mutants is indicated in the first column. Homogametic and heterogametic matings are tabulated in 2 x 2 arrays; the number of chambers run is given in parentheses following the total number of matings. Chi-square values for the contingency test, and the two goodness-of-fit tests of male and female mating equivalence are followed by their associated probabilities ($P < 0.05$)* and ($P < 0.001$)** Levene's sexual isolation index and its standard deviation are recorded in the last column for each test (Ayala and Tracey 1973).

	MARKERS	MALES	FEMALES A	FEMALES B	TOTALS	CHI-SQUARE TESTS 2 x 2	Males	Females	I
			(10)	(2)					
1.	wild, spa^{pol}	A (10)	44	15	59	12.01 (<0.001)**	13.88 (<0.001)**	2.92 (0.09)	0.22 ± 0.08
		B (2)	50	57	107				
		Totals	94	72	166 (9)				
			(9)	(1)					
2.	wild	A (9)	10	12	22	1.34 (0.24)	17.61 (<0.001)**	7.02 (0.01)*	0.24 ± 0.11
		B (1)	19	41	60				
		Totals	29	53	82 (4)				
			(9)	(4)					
3.	wild	A (9)	46	31	77	2.77 (0.09)	15.75 (<0.001)**	0.89 (0.37)	0.18 ± 0.01
		B (4)	15	20	35				
		Totals	61	51	112 (6)				
			(8)	(3)					
4.	yellow, spa^{pol}	A (8)	57	38	95	4.85 (0.03)*	0.35 (0.57)	0.35 (0.57)	0.17 ± 0.07
		B (3)	38	49	87				
		Totals	95	87	182 (10)				
			(7)	(5)					
5.	yellow	A (7)	31	16	47	0.01 (0.92)	2.09 (0.17)	7.72 (0.01)*	0.06 ± 0.11
		B (5)	22	12	34				
		Totals	53	28	81 (5)				

sex chromosome translocation-bearing competitors when they themselves hold an X chromosome that once carried a Y^L segment (Study 3).

In both yellow studies, T(X-Y) males and those without the translocation secure mates with equal frequency (Studies 4 and 5).

2 x 2 Chi-square and sexual isolation coefficients suggest varying degrees of discriminant mating effected by the T(X-Y), depending on genetic background. In $\underline{spa^{pol}}$ populations, there is significant positive assortative mating based on the T(X-Y), X//Y dichotomy; sexual isolation coefficients of 0.17 ± 0.07 and 0.22 ± 0.08 for $\underline{y}$ and $\underline{y^+}$ populations respectively were observed. These comparisons involved flies with wild-derived sex chromosomes (Studies 1 and 4).

Where T(X-Y) males are neither $\underline{yellow}$ nor $\underline{spa^{pol}}$ no significant assortative mating was found (Studies 2 and 3). However, where the X chromosome in question was natural (Study 2), there was observed excessive wild karyotype homogametic mating. This excess of X//X to X//Y matings, in $\underline{y^+}$ populations results in a calculated sexual isolation coefficient and standard deviation of 0.24 ± 0.11. Where the X chromosome of the X-Y population had been produced by recombination, $X{\cdot}Y^L//X{\cdot}Y^L$ females show a preference for T(X-Y) male mates while X·//X· females mate at random (Study 3). The result is an insignificant 2 x 2 Chi-square value. Nevertheless, T(X-Y) homogametic matings are in excess. Consequently, the total homogametic matings outweigh heterogametic ones to a degree, such that the sexual isolation coefficient approaches significance.

In addition, when flies are $\underline{yellow}$ and X-Y flies contain a synthetic X(X·), females do not discriminate against either $X{\cdot}Y^L//Y^S$ or X·//Y males. However, $X{\cdot}Y^L//X{\cdot}Y^L$ females are more highly receptive to both $\underline{yellow}$

males, than their X•//X• competitors. Consequently both 2 x 2 Chi-square and sexual isolation coefficient values are insignificant.

Sexual isolation based on the interaction of sparkling^{poliert}, yellow and X-Y translocation, and their wild counterparts: Neither yellow nor the presence or absence of the Y^L significantly affect mating success of males with yellow T(X-Y) femlaes. Yet yellow and the Y^L segment interact with Y^S to produce the mating advantage observed in X•Y^L//Y^S, yellow males (Tracey and Espinet 1976). Y^S is apparently the primary factor affecting the X•Y^L//Y^S, yellow male mating advantage, but this advantage is augmented by a yellow-X•Y^L interaction.

To substantiate the sexual isolation between T(X-Y) yellow and X-Y sparkling^{poliert} populations, the sexual isolation between flies with different combinations of the genetic markers was estimated. In addition to confirming our initial report, these experiments were designed to shed light on the nature of the X•Y^L-Y^S-yellow interaction.

Sexual isolation between T(X-Y), yellow and an (X-Y), wild strain is lower (0.27 ± 0.07) than that observed when the (X-Y) wild strain is also sparkling^{poliert} (0.58 ± 0.05). This reduction is the result of a higher frequency of X//Y male matings; 139 X//Y and 67 T(X-Y) yellow male matings (Table 6, study 1). Sparkling^{poliert} eliminates this X//Y male mating advantage; 116 X//Y, spa^{pol} and 139 T(X-Y) male matings were observed. Where both competing males are sparkling^{poliert}, T(X-Y) yellow males are outcompeted; 39 T(X-Y), yellow and 169 X//Y male matings respectively.

T(X-Y) yellow females enjoy a mating advantage over X//X wild ones, even when the latter are not spa^{pol}; 269 and 192 T(X-Y) yellow and X//X wild female matings respectively, over studies one and two of Table 6. Significant 2 x 2 chi-square values identify biased mating patterns in the

Table 6. Mating chamber studies of sexual isolation between populations differing by multiple genetic factors. The stock source of individuals employed in each study is listed in Table 1 and given in parentheses under the headings, Male and Female. Mating populations are designated A and B; homogametic and heterogametic matings are tabulated in 2 x 2 arrays. The number of chambers run are parenthesized following the total number of matings. Chi-square values for contingency tests, and the two goodness-of-fit tests of male and female mating equivalency are followed by their associated probabilities (P < 0.05*, P < 0.01**, P < 0.001***). Levene's sexual isolation coefficient (I) and its standard deviation (Ayala and Tracey 1973) for each test are also recorded. Interacting genetic variables affecting sexual isolation for each population are given in the last column.

	Male	Female A	Female B	Total	Chi-Square Tests 2 x 2	Males	Females	I	Interacting genetic variables A	Interacting genetic variables B
		(7)	(1)							
1.	A (7)	56	11	67	26.2 (<0.001)***	25.2 (<0.001)***	5.6 (<0.02)*	0.27 ± 0.07	T(X-Y) $\frac{y}{spa^{pol+}}$	X-Y $\frac{y^+}{spa^{pol+}}$
	B (1)	64	75	139						
	Totals	120	86	206 (9)						
		(7)	(2)							
2.	A (7)	117	22	139	83.4 (<0.001)***	2.1 (0.17)	0.58 (0.01)**	0.58 ± 0.05	T(X-Y) $\frac{y}{spa^{pol+}}$	X-Y $\frac{y^+}{spa^{pol}}$
	B (2)	32	84	116						
	Totals	149	106	255 (14)						
		(8)	(2)							
3.	A (8)	33	6	39	16.7 (<0.001)***	81.3 (<0.001)***	2.3 (0.14)	0.15 ± 0.07	T(X-Y) $\frac{y}{spa^{pol}}$	X-Y $\frac{y^+}{spa^{pol}}$
	B (1)	82	87	169						
	Totals	115	93	208 (12)						
		(9)	(2)							
4.	A (9)	78	71	149	1.9 (0.19)	59.0 (<0.001)***	0.01 (0.93)	0.08 ± 0.07	T(X-Y) $\frac{y^+}{spa^{pol+}}$	X-Y $\frac{y^+}{spa^{pol}}$
	B(2)	17	25	42						
	Totals	95	96	191 (8)						
		(3)	(4)							
5.	A (3)	18	3	21	6.2 (<0.01)**	30.4 (<0.001)***	6.0 (<0.02)*	0.06 ± 0.01	X-Y $\frac{y}{spa^{pol}}$	X•-Y $\frac{y^+}{spa^{pol+}}$
	B (4)	42	33	75						
	Totals	60	36	96 (5)						
		(7)	(4)							
6.	A (7)	94	9	99	24.1 (<0.001)***	8.0 (<0.01)**	15.9 (<0.001)***	0.48 ± 0.06	T(X-Y) $\frac{y}{spa^{pol+}}$	X•-Y $\frac{y^+}{spa^{pol+}}$
	B (4)	58	85	143						
	Totals	152	90	242 (13)						
		(6)	(5)							
7.	A (6)	16	15	31	1.5 (0.23)	1.4 (0.24)	2.7 (0.10)	-0.17 ± 0.12	$X \cdot Y^{L}\text{-}Y$ $\frac{y}{spa^{pol+}}$	X•-Y $\frac{y}{spa^{pol+}}$
	B (5)	27	14	41						
	Totals	43	29	72 (5)						
		(7)	(6)							
	A (7)	41	45	86	0.6 (0.46)	20.5 (<0.001)***	0.0 (1.00)	-0.07 ± 0.09	T(X-Y) $\frac{y}{spa^{pol}}$	$X \cdot Y^{L}\text{-}Y$ $\frac{y}{spa^{pol}}$
	B (6)	20	16	36						
	Totals	61	61	122 (7)						

above studies (see Table 6, experiments 1, 2 and 3). There is also a significant excess of homogametic matings--452 versus 217 overall. Sparkling^{poliert} superimposed on y^+, X//Y males in competition with T(X-Y) males which are also y^+, depresses X//Y male mating frequency; 149 and 42 T(X-Y) y^+ and X//Y, y^+ spa^{pol} male matings respectively. It does not however increase X//X female receptivity over that of their T(X-Y) counterparts. The 2 x 2 chi-square value is significant. The high sexual isolation coefficient observed in Study 2 may be due to a spa^{pol} X//Y interaction.

To further test the idea that the isolation is based on an interaction of y and T(X-Y) chromosomes (Espinet and Tracey 1976; Tracey and Espinet 1977), two more experiments were undertaken. The first test (Study 5 of Table 6) employed flies with wild karyotypes, but one of the populations contained both yellow and sparkling^{poliert} markers. In the second case (Study 6), one population was T(X-Y) yellow, while the other was X·//Y, y^+. Very little sexual isolation (0.06) was observed in Study 5, although chi-square values were all significant. Wild males experienced a mating advantage, as did yellow sparkling^{poliert} females. Similarly in Study 6, X//Y y^+ males and T(X-Y) yellow females hold the mating advantage, excessive homogametic matings result in a 2 x 2 significant chi-square and a high sexual isolation coefficient, 0.48 ± 0.06

Breakage and reunion of chromosome segments are more frequently observed in heterochromatic than in euchromatic regions (Yoon and Richardson 1977; White 1973). Variegation of gene expression in proximity to heterochromatin associated breaks is also well known (Baker et al. 1959; Spofford 1976). The yellow-X·-Y^L interaction enhancing X·Y^L//Y^S male fitness with X·Y^L//X·Y^L females is perhaps based on the proximal genes interacting

with the position of attachment of the Y^L to the XR; both Y^L and XR are highly heterochromatinized. To test this hypothesis, experiment 7 of Table 6 was done. In both populations, the Y-chromosome is normal. In A, the X chromosome is $X{\cdot}Y^L$, and in B, it is X·. The results indicate X· and $X{\cdot}Y^L$ equivalency; a lack of mating advantage by either of the males or females and no discriminant mating.

A substitution of a T(X-Y) yellow population for the X·-Yy population in the above experiment (7 of Table 6), was carried out in study 8. It is a control, executed to permit comparison of the present experiments with those carried out previously (Espinet and Tracey 1976, Tracey and Espinet 1976, Tracey and Espinet 1977). The results were identical to those in our previous work: $X{\cdot}Y^L//Y^S$ males enjoy a mating advantage over $X{\cdot}Y^L//Y$ males. Neither the 2 x 2 chi-square nor sexual isolation coefficient indicates sexual isolation due to duplication of the Y^L.

Rate of insemination of T(X-Y) and wild females by T(X-Y) and wild males respectively: Females may be induced to mate with males from which they are sexually isolated (Dobzhansky (1941). This induction is executed by diluting the stimuli elicited by sexually isolated males with those produced by acceptable males. The "mating atmosphere" reduces the stimulus threshold of the females to the degree where she accepts males from which she is normally sexually isolated. Well known also is the phenomenon that Drosophila melanogaster females mate infrequently; an average of once to twice per life time, while males may multiple mate. Previous experiments by necessity confounded stimuli, thus calculated values of sexual isolation between populations in above studies are probably conservative. Consequently to substantiate the sexual isolation between T(X-Y) and (X-Y) stocks, male

choice experiments were run (Table 7). In addition, in order to differentiate between matings based on inherent preference and those due to artificial induction by excessive stimulation, data from the first twelve matings and the total matings were analysed separately (Ehrman 1969). The X-Y individuals bore X• chromosomes (Stock 4 of Table 1). The T(X-Y) individuals came from Stock 9 of Table 1. Charles Stalker's sexual isolation index (Ohta 1978) ((homogametic matings - heterogametic matings) ÷ Total matings) were employed in the calculation of sexual isolation coefficients. The results are given in Table 7.

Table 7. T(X-Y) (A) versus X•-Y (B) female mating success with A and B karyotype males. Stock source for individuals in each test is listed in Table 1 and given in parentheses under the heading, Male. The $X•Y^L$ chromosome is y f car. In T(X-Y) males, the y^+ is Y-linked. The X• chromosome is y^+ f car. The first 12 matings of each run were analysed separately from the total matings. The total matings, T(X-Y) female matings, X•-Y female matings, chi-square values (1 d.f. for 50:50 expectation), their associated probabilities ($P < 0.05$)*, ($P < 0.01$)**, Charles Stalker's sexual isolation index (I) (Ohta 1978) and standard deviation are recorded in the last six columns.

Males	N Matings	T(X-Y) females	X•-Y females	Chi-square	I
1 a A (9)	60	39	21	5.4 (0.02)*	0.3 ± 0.14
b A (9)	109	55	54	0.01(<0.90)	0.02 ± 0.09
2 a B (4)	60	40	20	6.67(<0.01)*	-0.33 ± 0.27
b B (4)	108	58	50	0.59(<0.50)	-0.07 ± 0.24

Data from early matings suggest T(X-Y) females are more receptive to both T(X-Y) and X•-Y males than are (X•-Y) females (see also Table 5, study 5). In addition, sexual isolation (I = 0.3 ± 0.14) between $X•Y^L//Y^S$ and X•//X• females, and an X•//Y male mating advantage with $X•Y^L//X•Y^L$ females (40 $X•Y^L//X•Y^L$ females and 20 X•//X• females matings) were masked

when data from total matings from each run were observed. These results are consistent with the hypothesis that sexual isolation coefficients calculated from multiple choice experiments are conservative values.

Dominance-recessive relationship of $X \cdot Y^L$ and X with regard to female choice of mates, based on male X or Y chromosomes. Drosophila melanogaster males have been described as actively indiscriminate and females as passively indiscriminate with regard to mate selection (Bastock and Manning 1955). Females choose to mate when male stimuli lower their mating threshold to a degree where copulation is allowed. To investigate which sex chromosome of the male, the X or Y, is the chief determinant of acceptance by females as well as the dominance-recessive relationship of the $X \cdot Y^L$ and X chromosomes in females, mating success studies were carried our using P and F_1 males in competition for $X//X \cdot Y^L$ heterozygotic females. The results are listed in Table 8. Experiments 1, 3 and 4 indicate that X, y^+ is dominant to $X \cdot Y^L$, and the y^+ heterozygotes show a preference for y^+ males; 485 and 138, y^+ and y males respectively, regardless of Y chromosome morphology. However, y heterozygotic females choose $X \cdot Y^L$ males; 148 and 54, $X \cdot Y^L$ and X-bearing yellow males respectively (see study 2, Table 8). In study 5, Y^S males bear a y^+ Y-linkage marker. When these males are fertile, a nearly significant mating advantage is observed. Chi-square value and its probability is 3.6 ($P < 0.059$).

Phenocopy Experiments: Phenocopy-nongenetic induction of a yellow phenotype by larval feeding of α-dimethyltyrosine (α-DMT) has been reported (Burnet, Connolly and Harrison 1973). As this technique would allow comparisons between normal and yellow flies, attempts were made to induce

Table 8. Mating success studies of P (a) and F_1 (b) males to F_1 X//X·Y^L (A//B) females in (a) backcrosses and (b) F_1 intercrosses. F_1 individuals were produced in reciprocal P crosses involving stocks parenthesized under the heading, Female (see Table 1). The X·Y^L chromosome is y f car. The X in experiments 1a and b, and 5a and b is X· (see Materials and Methods). The yellow marker and its wild allele is X-linked except where otherwise indicated. The number of chambers run, total matings, male mating frequencies, chi-square goodness-of-fit test of male mating equivalence, and their associated probabilities (P < 0.001)* for each test are given in the last six columns.

Cross	Female A//B	Male A	Male B	N Run	N Matings	Male Matings A	Male Matings B	Chi-Square	Probability
1a	(4)//(7)	Y	Y^S	5	82	59	23	15.81	(<0.001)*
1b	(4)//(7)	Y^S	Y	4	68	66	2	58.73	(<0.001)*
2a	(3)//(8)	Y	Y^S	6	103	32	71	14.76	(<0.001)*
2b	(3)//(8)	Y^S	Y	7	99	22	77	30.56	(<0.001)*
3a	(2)//(7)	Y	Y^S	4	88	65	23	20.05	(<0.001)*
3b	(2)//(7)	Y^S	Y	6	130	105	25	49.23	(<0.001)*
4a	(1)//(7)	Y	Y^S	6	98	86	12	55.88	(<0.001)*
4b	(1)//(7)	Y^S	Y	8	157	104	53	16.56	(<0.001)*
5a	(4)//(9)	Y	$Y^S y^+$	4	47	17	30	3.6	(<0.059)
5b	(4)//(9)	$Y^S y^+$	Y	5	39	21	18	0.23	(<0.63)

phenocopies in the stocks used in these studies and in Amherst strains similar to those used in the initial report (Burnet et al. 1973). My initial attempts involved substitution of Instant Drosophila Media (Carolina Biological Supply) for the chemically defined media employed by Burnet and coworkers. No phenocopies were obtained (Espinet 1976). Subsequent attempts employed the chemically defined media (Table A2 of Appendix A); no phenocopies were found (Table 9).

Y^S fitness studies: In cage populations of $X \cdot Y^L$, Y^S and Y bearers, the Y^S estimates of relative fertility ($X \cdot Y^L // Y^S \div X \cdot Y^L // Y$) in small populations suggested that the Y^S fertility advantage is frequency dependent (Tracey 1972). Unfortunately the small populations did not provide a sufficient range of Y^S frequencies to allow an adequate test of the frequency dependent hypothesis. In $X \cdot Y^L // X \cdot Y^L$ cage studies where Y and Y^S initiation frequencies were equivalent, the Y^S reached a frequency of 0.95 by the third generation and was maintained at or above that level until the experiment was terminated. To test the hypotheses that this represents a stable equilibrium frequency for the Y^S chromosome, and that Y^S selection is frequency dependent, a series of population cages containing 400 $X \cdot Y^L // X \cdot Y^L$ females and Y^S frequencies of 0.99, 0.75 and 0.50 were initiated. Y^S and Y male matings were scored in these cages (see Materials and Methods).

The frequency of $Y^S y^+$ over three generations is recorded in Table 10 for two cages initiated at Y^S frequencies of 0.99 and 0.75, and over two generations for a cage started at Y^S equal 0.50. The Y^S chromosome frequency change is consistent with the predictions of a stable equilibrium point near 0.97. The Y^S change is positive in all but the 0.99 cage, where a Y^S decrease was observed. The Y chromosome frequency (q) can be treated in selection

Table 9. F_1 phenotypes of larvae cultured on various concentrations (g/100 ml) of α-dimethyl tyrosine (α-DMT). The experimental stocks are denoted by their paternal geotypes. The emergent yellow females are followed by their wild siblings of the F_1 generation.

	Concentration %	Stock	yellow males	yellow females	wild males	wild females
1	0	X//Y, Am	0	0	280	261
2	0	X//Y, Am	0	0	149	114
3	0	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	172	158	0
4	0	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	216	190	0
5	0.038	X//Y, Am	0	0	177	201
6	0.038	X//Y, Am	0	0	189	223
7	0.038	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	207	201	0
8	0.038	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	111	86	0
9	0.075	X//Y, Am	0	0	277	381
10	0.075	X//Y, Am	0	0	188	293
11	0.075	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	167	171	0
12	0.075	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	122	118	0
13	0.15	X//Y, Am	0	0	146	162
14	0.15	X//Y, Am	0	0	179	222
15	0.15	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	154	136	0
16	0.15	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	148	137	0
17	0.3	X//Y, Am	0	0	139	41
18	0.3	X//Y, Am	0	0	55	48
19	0.3	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	32	27	0
20	0.3	$X \cdot Y^L//Y^S\underline{y}^+$, T(X-Y)	0	50	46	0

Table 10. The frequency change of $X \cdot Y^L // Y^S \underline{y}^+$ (A) and $X \cdot Y^L // Y$ (B) males over three generations for two cages initiated at 0.99 and 0.75 and over two generations for a cage initiated at 0.50 A males (see Materials and Methods). Females are $X \cdot Y^L // X \cdot Y^L$, $\underline{y}$ $\underline{f}$ $\underline{car}$ and comprise 50% of the initial population. The Y^S frequency in each generation is listed under the heading, q.

	Initial Cage			Generation I				Generation II				Generation III			
	A	B	q	A	B	Females	q	A	B	Females	q	A	B	Females	q
1.	396	4	0.99	448	8	761	0.98	847	27	1186	0.96	608	12	648	0.98
2.	300	100	0.75	405	120	758	0.77	902	60	1020	0.93	1190	23	1272	0.98
3.	200	200	0.50	239	64	250	0.79	793	52	930	0.94				

models as a haploid system.

$$q_{t+1} = q_t(1 - s)$$

Selection coefficients can then be estimated by solving

$$s = 1 - \frac{q_{t+1}}{q_t}$$

These s values were calculated from the three cages and from Tracey's cage data (Tracey 1972). They are presented in Table A4. The change in s is dependent on the Y^S frequency (see Fig. 5). The regression coefficient equals 0.86 and the slope is significantly positive ($t = 9.2$, $p < 0.01$).

The estimated relative viability of $X{\cdot}Y^L//Y^S$ and $X{\cdot}Y^L//Y$ males is 1.00 (Tracey 1972); therefore the observed Y^S frequency change is likely to be the result of fertility differences. In order to assess fertility differences, one component of fertility, relative mating success, was assayed by scoring female mating at initial male frequencies, and the results are given in Table 11. The number of females mated to $X{\cdot}Y^L//Y^S$ and $X{\cdot}Y^L//Y$ males is significantly greater than expected at frequencies below 0.98. Substituting in

$$s = 1 - \frac{q_{t+1}}{q_t}$$

where q_{t+1} and q_t represent the observed and expected mating frequencies we get $s = 1 - \frac{0.894}{0.75} = -0.192$ at $q_t = 0.75$ and $s = 1 - \frac{0.765}{0.5} = -0.53$ at $q_t = 0.50$. If we assume that all females mate twice, then we can also calculate s at $Y^S = 0.99$. Under this assumption, $s = 1 - \frac{0.998}{0.99} = -0.008$,

Figure 5. Change in Y^S selection coefficient (s) with change in Y^S frequency (q) in populations where X chromosomes are $X \cdot Y^L$, y f car and Y chromosomes are Y and $Y^S y^+$. S values were calculated by solving $s = 1 - (q_{t+1}) \div q_t$, using cage data from Table 10 (open circles), Tracey (1972) (closed circles), mating frequencies from Table 11 (crosses) and setting $q_{t+1} = 1$ for various values of q_t (s_{max})(triangles).

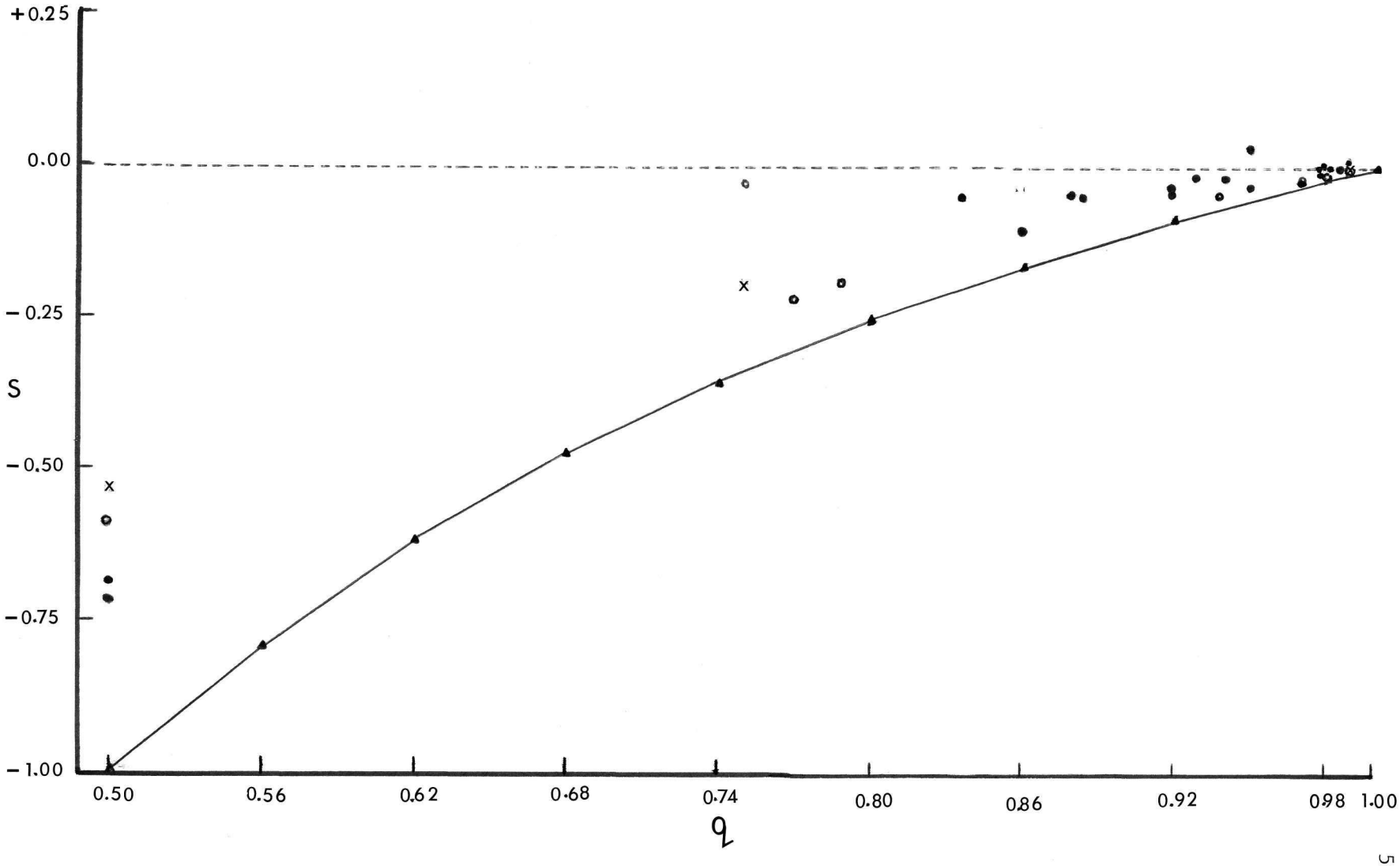


Table 11. Mating success of $X{\cdot}Y^{L}//Y^{S}\underline{y}^{+}$ (A) and $X{\cdot}Y^{L}//Y$ (B) males to $X{\cdot}Y^{L}//X{\cdot}Y^{L}$ females when A males are at frequencies of 0.99, 0.75 and 0.50 in population cages (see Materials and Methods). The $X{\cdot}Y^{L}$ is $\underline{y}\ \underline{f}\ \underline{car}$ and females comprise 50% of populations of 800. A and B matings, total matings (N), expected A matings, chi-square values and probabilities ($P < 0.001$)* are recorded in the last column. Data on multiple matings were excluded (Ohta 1978).

	Males		A	B	N	Exp. A	Chi-square	P
	A	B	Matings	Matings	Matings	Matings		
1.	396	4	196	0	196	194	2.02	(0.250)
2.	300	100	185	22	207	155	28.12	(<0.001)*
3.	200	200	199	61	260	130	73.25	(<0.001)*

a value which is not significantly different from zero.

Fitness estimates of $X{\cdot}Y^L//Y$ and X//Y males suggested that X//Y males enjoyed an advantage due primarily to a higher fertility (Tracey 1972). In addition, X//Y, $\underline{y}^+$ males enjoy a mating advantage over $X{\cdot}Y^L//Y^S$ yellow males when females are X//X (Tracey and Espinet 1976). Further, relative male fertility ($X//Y \div X{\cdot}Y^L//Y$) appears to depend on female state; highest when females are X//X and lowest when females are homozygous for the $X{\cdot}Y^L$ chromosome (Tracey 1972). To test the frequency dependent hypothesis of rate of change of Y^S in a population, where males are X//Y and $X{\cdot}Y^L//Y^S$, population cages containing 400 $X{\cdot}Y^L//X{\cdot}Y^L$ females and $X{\cdot}Y^L//Y^S$ males at frequencies of 0.99, 0.75 and 0.5 were initiated. Female mating frequency was scored. The number of females mated to $X{\cdot}Y^L//Y^S$ and $X//Y,\underline{y}^+$ males are given in Table 12. The results are inconsistent with the frequency dependent hypothesis, as $X{\cdot}Y^L//Y^S$ males mate as expected under the hypothesis of no selection, when competing males are $X//Y\underline{y}^+$ (Tracey and Espinet 1976).

Sequential differentiation of the elements of courtship behaviour of T(X-Y), y and y^+ and T(X·-Y), y^+ stocks: Vibration bout length has been reported to be the significant element characterizing the degree of excitability experienced by a courting D. melanogaster male (Bastock and Manning 1955). In addition, fruit flies' love songs, apparently unique and invariable in most species, have been demonstrated to be associated with the upstroke of the wing during vibration (Bennet-Clark and Ewing 1970). Further, yellow male mating disadvantage with wild females is seemingly due to shorter wing display bouts between longer intervals than those performed by wild males (Bastock 1956). Nonetheless, males may

Table 12. Mating success of $X \cdot Y^L // Y^S$ (A) and $X // Y, y^+$ (B) males to $X \cdot Y^L // X \cdot Y^L$ females when A males are at frequencies of 0.99, 0.75 and 0.50 in population cages (see Materials and Methods). The $X \cdot Y^L$ is y f car and females contribute to 50% of populations of 800. A and B matings, total matings (N), expected matings, chi-square values and their probabilities are recorded in the last six columns. Data on multiple mating were excluded (Ohta 1978).

	Males		A	B	N	Exp. A	Chi-square	P
	A	B	Matings	Matings	Matings	Matings		
1.	396	4	318	6	324	321	3.03	(0.08)
2.	300	100	183	74	257	193	2.08	(0.17)
3.	200	200	123	104	227	114	1.43	(0.18)

court as persistently and successfully when dewinged as when winged (Averhoff and Richardson 1976). The temporal patterning of the elements in unstereotyped courtship behaviour, as is found in Drosophila melanogaster, was observed and analysed by Nelson (1964). From the behaviour of a single pair of fishes (Glandulocauda), Nelson showed that the elicitation of a specific behavioural element was not independent of the elements preceeding it. As differential mating success was observed among T(X-Y) males, mating sequences were examined in an attempt to detect differences (see Materials and Methods). Occurrence probabilities of courtship element triplets are recorded in Figure 6.

Elements of behaviour observed in triplet-groups with a probability of occurrence greater than 0.01 based on their observed frequency for courting were:

female preening (3)

male standing 1 mm directly behind females (11)

male scissoring (12)

male following female (14)

male vibrating (15)

male licking female genitals (16)

male abdomen curling (17)

male circling (19)

male attempted mating (mated) (20)

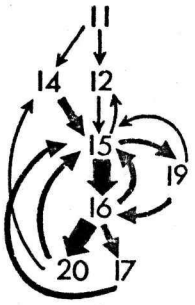
Parenthesized numbers are those of Appendix A, Table A3. All three stocks exhibit a common sequence 11 → 12 → 15 → 16. Interstock variation, superimposed on this standard, characterizes the courtship patterns observed in different stocks.

Figure 6. Temporal pattern and probability of performance of triplets of elements of courtship behaviour in T(X-Y), y, T(X-Y), y^+, and X--Y, y^+. Drosophila melanogaster stocks (Stocks 7, 9, and 4 of Table 1). Behavioural elements are represented numerically (see Appendix A, Table A3). Sequences of triplets (S) are listed in the first column of every study, followed by their associated probability of occurrence (P). Triplets having probabilities of less than 0.01 are not included. Flow diagrams of the probable sequencies of performance of courtship behaviour elements for each pair of flies are also recorded. The probability that a given behaviour is followed by that indicated by each arrow, is represented by the thickness of the arrow.

T(X-Y), yellow

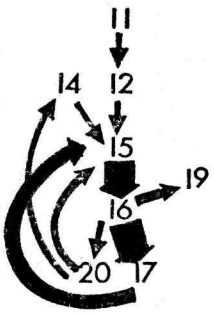
Trial I

	S	P
1.	15,16,20	0.064
2.	14,15,16	0.032
3.	15,16,15	0.028
4.	16,15,16	0.021
5.	16,17,15	0.021
6.	20,15,16	0.021
7.	17,15,16	0.018
8.	15,16,17	0.018
9.	15,19,16	0.018
10.	11,12,15	0.014
11.	20,14,15	0.014
12.	11,14,15	0.011
13.	19,15,12	0.011
14.	19,16,15	0.011
15.	19,16,20	0.011



Trial II

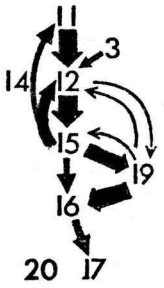
	S	P
1.	15,16,17	0.100
2.	17,15,16	0.050
3.	16,17,15	0.050
4.	15,16,19	0.038
5.	20,15,16	0.031
6.	16,20,14	0.025
7.	11,12,15	0.019
8.	14,15,16	0.019



T(X-Y), y^+

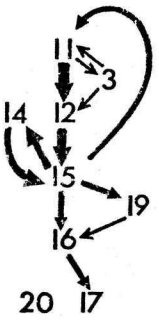
Trial I

	S	P
1.	11,12,15	0.062
2.	15,19,16	0.051
3.	15,12,15	0.045
4.	12,15,19	0.042
5.	19,16,17	0.025
6.	15,11,12	0.025
7.	12,15,11	0.025
8.	15,16,17	0.022
9.	3,12,15	0.016
10.	19,15,16	0.014
11.	19,12,15	0.014
12.	12,19,16	0.014



Trial II

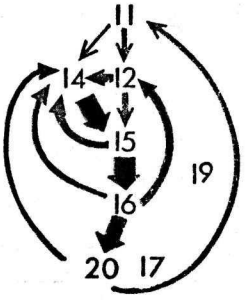
	S	P
1.	11,12,15	0.035
2.	15,14,15	0.029
3.	14,15,14	0.023
4.	14,15,16	0.018
5.	12,15,19	0.018
6.	15,16,17	0.018
7.	15,11,12	0.018
8.	11, 3,11	0.018
9.	3,12,15	0.018
10.	19,16,17	0.01



X-Y, y^+

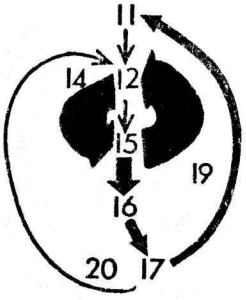
Trial I

	S	P
1.	14,15,16	0.073
2.	15,16,20	0.05
3.	16,12,14	0.032
4.	15,14,15	0.027
5.	16,14,15	0.023
6.	20,14,15	0.023
7.	11,12,15	0.023
8.	15,16,14	0.018
9.	12,14,15	0.018
10.	16,20,11	0.018
11.	11,14,15	0.014



Trial II

	S	P
1.	15,12,15	0.174
2.	12,15,12	0.146
3.	12,15,16	0.046
4.	15,16,17	0.037
5.	16,17,11	0.027
6.	11,12,15	0.01
7.	17,12,15	0.01



Overall sequence variation: Males may follow females (14 → 15) before vibration is elicited. In addition, males may circle females after vibrating and before licking (15 → 19 → 16), or after licking. In the latter case, "after circling" males may enter the sequence at scissoring, vibrating or they may return to licking. Vibrating may be interrupted by scissoring or prior to periods of male inactivity during which the male may stand approximately 1 mm directly behind the female facing her genitalia, or vibrating may preceed periods of male following. Licking may lead into male abdomen curling or attempted copulation. In some cases, it may be preceeded by scissoring or female-following. Abdomen lowering may be succeeded by vibrating, scissoring or standing quietly and closely behind the female. Similarly, attempted copulation, if not successful, may be followed by the male's remaining stationary behind the female if she stands, pursuing her if she walks away or vibrating. In many instances, weak attempts at element 20 and forceful execution of 17 were indistinguishable to the investigator. Failure to elicit the behavioural element next in sequence results in the flies' reentry into the sequence at any point from the initial element (11) to that directly preceding the unattained element which led to sequence interruption.

Courtship sequence variation between T(X-Y), yellow and wild body-coloured flies: Unlike that of the yellow stock, the y^+ male scissoring appears to depend on female preening for its elicitation. In addition, scissoring or following the female is more likely to succeed a bout of vibration during y^+ male courtship than during that of the y male. P(15 → 12) and P(15 → 14) range between <0.01 to 0.042 and <0.01 to 0.029 respectively for y^+ males and <0.01 to 0.011 and <0.01 respectively for y

males. Furthermore, sequences involving mating attempts are more probable in the courtship of T(X-Y), yellow males. P(15 → 16 → 20) has a value of 0.064 and <0.01 in y and y^+ stocks respectively. As a result the initial sequences are less probable in yellow males than in their wild counterparts. P(11 → 12 → 15) ranges between 0.014 and 0.019 for yellow males and between 0.035 and 0.062 for y^+ males. The terminal sequence (15 → 16 → 17) had a higher probability of occurrence in T(X-Y), yellow stocks than for wild bodied T(X-Y) stocks. P was 0.018 and 0.10 for T(X-Y) yellow males and 0.018 and 0.022 for their T(X-Y), y^+ counterparts. Circling appears to play a more significant role in T(X-Y), y^+ mating behaviour than it does in that of T(X-Y), y stocks. The sequence (15 → 19 → 16) probability was 0.051 in y^+ (Trial I) and 0.018 in yellow (Trial I). The probability that interruptions in the courtship sequence result in resumption at the beginning of the initial sequence (11) is also higher in y^+ than y stocks.

Courtship sequence variations between T(X-Y) y^+ and X•-Y y^+ flies: The triplet sequences (12 → 15 → 19) and (15 → 19 → 16) have a higher probability of occurrence in the T(X-Y), y^+ stocks. P ranges from 0.018 to 0.042 for the former sequence, and P is as high as 0.051 for the latter, while in the X•-Y y^+ stock the probabilities of occurrence of both sequences are less than 0.01. Thus circling does not play a significant role in the main body of the courtship sequence of X•-Y y^+ flies. In addition, in T(X-Y) stocks the probability of observing the initial element of the standard courtship sequence (11 → 12 → 15) is higher than in X•-Y populations. P was between 0.035 and 0.062 for T(X-Y) stocks and between 0.01 and 0.023 in X•-Y stocks. Further, the probability of occurrence of

sequences ending in attempted mating is higher for X•-Y stocks ($P = 0.05$) than in T(X-Y) ones ($P < 0.01$).

Courtship sequence variation between T(X-Y) yellow and X•-Y, y^+ stocks: The probability of circling (19) occurring in one of the triplet sequences with a frequency of greater than 1 in 100, is greater in yellow translocation stocks than in X•-Y ones: $P = 0.163$ for Trial I and 0.11 for Trial II in T(X-Y), y and $P < 0.01$ for X•-Y stocks. The initial sequence (11 → 12 → 15) has a higher probability of occurrence in X-Y stocks: ranging from 0.01 to 0.023 in X•-Y y^+ and from 0.014 to 0.019 in T(X-Y), y stocks. In X•-Y, y^+ stocks the probability of sequence resumption at behaviour element (11) following attempted mating is 0.018; in yellow sex chromosome translocation stocks it is less than 0.01.

The variation in sequence position of the behavioural element "male following female" varies within and between stocks.

DISCUSSION AND CONCLUSION

Sparkling^{poliert} marker allele effects on $X{\cdot}Y^{L}//Y^{S}$-X//Y sexual isolation: Sparkling^{poliert} reduces male activity. However, it does not appear to affect the quality of male courtship or female receptivity (see Table 2), since spa^{pol+} and spa^{pol} females mate with wild and spa^{pol} mutant males in equal proportions.

Yellow marker allele effects on $X{\cdot}Y^{L}//Y^{S}$-X//Y sexual isolation: We have reported that yellow as the principal genetic difference between Drosophila melanogaster males, did not significantly affect male mating success with $X{\cdot}Y^{L}//X{\cdot}Y^{L}$ females (Tracey and Espinet 1976). Threlkeld (1974) demonstrated that increased preference for y bearing males could be selected for in D. melanogaster, yellow females. Outcrossing our stocks to a wild strain produced a y^{+} male mating advantage in these studies (see Table 3 studies 8 and 9). Our initial stocks were y f car$\cdot Y^{L}//Y^{S}y^{+}$. These were synthesized from y f car//Y stocks and it is possible that the natural female preference for normal body coloured males was selectively lost in this stock before the $Y^{S}y^{+}$ chromosome was introduced. Thus, our initial report of equivalence appears to be the result of loss of X-borne mating perference alleles in the females. Overall y^{+} males court more successfully than their y counterparts (Bastock 1965, Manning, 1965, Threlkeld 1974), and this may contribute to an activity rather than discrimination component of sexual isolation (Kence and Bryant 1978).

However, where normal X chromosomes were used to compare yellow and wild males, no difference was observed (Table 4, study 1 column A), since yellow females mated equally as frequently with yellow and wild bodied

males. The sexual isolation observed in this study is asymmetric (sexual isolation in one direction and not in the other (Ohta 1978)), and although significant (0.33 ± 0.07) is probably partially activity based. Unfortunately, we were unable to partition the activity and discrimination components in this experiment. Nonetheless, since $\underline{spa}^{pol}$ reduces activity, the equivalence of $\underline{y}^+$ and $\underline{y}$ bearing male mating success, with yellow females, in the first study of Table 4 is perhaps explained.

In the second study of Table 4, the total number of matings (33) is low, less than 50% of that expected (72). The observed high sexual isolation coefficient (0.58 ± 0.14) is perhaps a function of the number of matings. The experiment should therefore be repeated. On the other hand, (symmetric) positive assortative mating is clear, the X chromosome is X·, and the sexual isolation coefficient observed in this study, is not unlike that observed between X//Y and $X \cdot Y^L // Y^S$ populations (study2of Table 6 (0.58 ± 0.05) which is representative of isolation attributable to a yellow and a particular sex chromosome combination. Comparisons of X· $\underline{y}$ and $X \cdot Y^L$ $\underline{y}$ chromosomes in Y bearing males (see Table 6, study 7), suggest that the Y^L attachment alone has no effect on male mating success with $X \cdot Y^L // X \cdot Y^L$ females . These results are identical to those previously reported (Tracey and Espinet 1976), where the $X \cdot Y^L // Y$, $\underline{y}$ male mating advantage over X//Y, $\underline{y}$ males with $X \cdot Y^L // X \cdot Y^L$ females was attributed to a positive ($\underline{y}$) (Y^L) interaction (Tracey and Espinet 1976). A position effect involving the yellow allele and the X-Y translocation that augments male mating success was apparent in previous studies, from experiments which employed X $\underline{y}^+ // Y^S$, $X \cdot Y^L \underline{y} // Y^S \underline{y}^+$ and X $\underline{y}^+ // Y$ males with $X \cdot Y^L // X \cdot Y^L$ females. It was clear that $X \underline{y}^+ // Y$ and $X \cdot Y^L // Y^S y^+$ males enjoyed a mating advantage, while X $\underline{y}^+ // Y^S$ did not (Espinet and Tracey 1976, Tracey and Espinet 1977).

A negative ($\underline{y}^+$) (T(X-Y)) interaction is observed when $\underline{y}^+$ is borne on the X· (study 3 of Table 5). $X{\cdot}Y^L/\!/Y^S\underline{y}^+$ males, where the $\underline{y}^+$ is borne on the Y^S, enjoy a mating advantage over $X{\cdot}\underline{y}^+/\!/Y$ males. Clearly this advantage is expressed in an asymmetric sexual isolation pattern, where $X{\cdot}Y^L/\!/X{\cdot}Y^L$ females discriminate against $X{\cdot}/\!/Y,\underline{y}^+$ males, but $X{\cdot}/\!/X{\cdot},\underline{y}^+$ females readily accept both $X{\cdot}/\!/Y,\underline{y}^+$ and $X{\cdot}Y^L/\!/Y^S,\underline{y}^+$ males.

Removal of the ($\underline{y}^+$) (T(X-Y)) interaction as in normal X's (Table 5, study 2), results in the reversal of the direction of asymmetrical isolation. X/⁄Y males enjoy a mating advantage over $X{\cdot}Y^L/\!/Y^S$ $\underline{y}^+$ males based on X/⁄X,$\underline{y}^+$ female discrimination against T(X-Y),$\underline{y}^+$ males as mates, whence X/⁄X,$\underline{y}^+$ females become fitter than their $X{\cdot}Y^L/\!/X{\cdot}Y^L$ counterparts. This fitness differential is probably due to activity differences attributable to $\underline{y}^+$ on normal X chromosomes, relative to $\underline{y}$ on $X{\cdot}Y^L$ chromosomes. This, because it disappears on the introduction of $\underline{\text{sparkling}}^{\underline{\text{poliert}}}$ (Table 5, study 1), which does not give rise to appreciable sexual isolation, but raises the T(X-Y) females matings relative to that of (X-Y),$\underline{y}^+$ females.

The (<u>yellow</u> locus) (T(X-Y)) interactions are expressed in opposite directions such that introduction of a ($\underline{y}^+$) (T(X-Y)) interaction in a population which previously showed some sexual isolation from a second population containing a ($\underline{y}$) (T(X-Y)) interaction would tend to increase the isolation masked by increased $\underline{y}^+$ male activity. (Compare studies 1 and 2 with study 6 of Table 5). Further, addition of a (y) (T(X-Y)) interaction to X/⁄Y,$\underline{y}$ males, increases their mating frequency relative to $X{\cdot}Y^L/\!/Y$ males such that $X{\cdot}/\!/Y,\underline{y}$ and $X{\cdot}Y^L/\!/Y$ males appear to mate at equal frequencies with both $X{\cdot}Y^L/\!/X{\cdot}Y^L$ and X·//X· <u>yellow</u> females (see Table 6, study 7 & Table 5, study 4). The indication is then, that the sexual isolation coefficient measured in

study 2 of Table 4 ($X \cdot \underline{y}//Y$ vs $X \cdot \underline{y}^{+}//Y$) is based on the yellow allele, plus the X-Y translocation and a position effect (Haldane 1932, Spofford 1976). A position effect of this type could, conceivably, arise in either of two ways. First, the X• generated from $X \cdot Y^{L}$ could have arisen through a translocational break in an easily broken region. This would leave, perhaps, some Y material on the X. Second, the X• may have acquired, during its $X \cdot Y^{L}$ existence, changes in the genes proximal to the centromere which account for the maintenance of interaction in the absence of Y^{L}. We are not able to distinguish between these possibilities nor even to say that one or the other must hold. Nonetheless, a similar case has been reported in Papilio glaucus. Clarke and Sheppard (1976) in an attempt to explain the occasional production of yellow female daughters by black female Papilio glaucus L. (the mimetic tiger swallowtail butterfly), containing heterochromatin Smith bodies, were hesitant to invoke Haldane's suggestion of X-Y (Z-W) translocation and position effect control of female colour polymorphism. However, their cytological studies strikingly supported Haldane's view that heterochromatin is involved in the expression of the black phenotype. This, because yellow females and males lacked Smith bodies, and occasionally yellow females gave rise to black daughters. Their difficulty in accepting Haldane's suggestion was due to their acceptance of the view that crossing over in the female lepidoptera was non-existent. We pointed out an analogous situation where crossover in male D. melanogaster was believed non-existent, but has been shown to occur in low frequencies (Kidwell and Kidwell 1971), and suggested that Haldane's explanation should be reconsidered. Interestingly the yellow non-mimetic form of P. glaucus behaved like those of a minority of species

where Smith bodies are absent from both sexes. More interestingly, F_1 females from a black female glaucus x yellow male rutulus (allopatric species) were made to eclose using α-ecdysterone. The F_1 insect was intermediate in colour. The comment that the yellow colour perhaps was due to a Z-W (X-Y) interaction lends support to Haldane's suggestion (Clarke, personal communication 1977).

T(X-Y) effects on $X \cdot Y^L // Y^S$-X//Y sexual isolation: Sexual isolation based on the sex chromosome translocation may be symmetric, asymmetric or non-existant depending on the population genetic background. In yellow sparkling poliert populations, it is symmetric (study 4 of Table 5). Where the representative of the wild karyotype X is X·y (study 5 of Table 5), no significant sexual isolation was measured. Evidently X· y and $X \cdot Y^L$ y females discriminate against neither X·//Y nor $X \cdot Y^L // Y^S$ males. Yet an $X \cdot Y^L // Y^S$ male mating advantage with $X \cdot Y^L // X \cdot Y^L$ females is apparent. The hypothesis that this advantage is based on a (y) (Y^L) and (y) (Y^S) interaction (Tracey and Espinet 1976) is supported, note X·//X· yellow females are less fit than their $X \cdot Y^L // X \cdot Y^L$ counterparts.

A (y) $(Y^L)(Y^S)$ positive interaction is also apparent from study 8 of Table 6, where $X \cdot Y^L // Y^S$ males have mated more successfully to $X \cdot Y^L // X \cdot Y^L$ females than did $X \cdot Y^L$//Y males. These results are consistent with those received from previous similar studies (Tracey and Espinet 1976). The indication then, is that present results and those obtained in earlier studies could be directly compared.

Overall, in various genetic backgrounds the mating pattern among T(X-Y) and (X-Y) individuals varies. We find random mating, asymmetric mating, where females from one of the stocks, (X-Y), discriminated against males from the other stock, T(X-Y), asymmetric mating in the opposite

direction and symmetric positive assortative mating. Yet where significant sexual isolation is observed, isolation coefficients due to the sex chromosome translocation were calculated to be around 0.2; a value not dissimilar to that found for two subspecies in the genus Drosophila, w. willistoni and w. quechua (Ayala and Tracey 1973). An additional interesting analogy exists between the subspecies D. w. willistoni and and w. quechua, and the T(X-Y) and (X-Y) stocks of D. melanogaster. D. w. quechua males crossed with D. w. willistoni females produce fertile progeny in both sexes. However, D. w. quechua females crossed to D. w. willistoni males from Colombia, Venezuela, Trinidad and Brazil, produce sterile males, though females are fertile. On the other hand, D. w. willistoni males from Equador, Central America and Mexico, when crossed with D. w. quechua females, produce fertile males and females. In addition, local populations of D. w. willistoni exhibit subspecific levels of sexual isolation, but little genetic divergence. Since females may be induced to mate with males from which they are sexually isolated (Dobzhansky 1941), and this induction is attained through dilution of stimuli elicited by sexually isolated males, with those stimuli produced by acceptable males, sexual isolation coefficients measured in multiple choice on experiments perhaps result in conservative measures of the actual isolation. In addition, mating speed may affect the symmetry, and the value of sexual isolation (Kence et al.1978). Male choice experiments do not contain confounded stimulation produced by more than one male. Sexual isolation coefficients measured from male choice experiments (Table 7), and based on the sex chromosome translocation is approximately 0.3, between T(X-Y) males crossed to X•-Y females. The isolation index calculated in

this case was Charles Stalker's isolation index (Ohta 1978), and is essentially the same as the calculation used to measure sexual isolation observed in multiple choice mating studies. The differential between the sexual isolation coefficients measured in multiple and male choice experiments, is consistent with the idea that, measurable sexual isolation is masked in multiple choice experiments.

Under the hypothesis of additivity of the sexual isolation due to various genetic markers, an expected value of the sexual isolation coefficient measured in two populations, where one contained a sex chromosome translocation of the type in question, and the yellow allele is approximately 0.53. The observed value, 0.58 ± 0.05 (Table 6 study 2) is not significantly different from that expected.

Phenocopies of yellow: It was hoped that some insight into the (y)(T(X-Y)) interaction and position effect could perhaps be obtained by observations of yellow phenocopies of y^+ bearing stocks. However, in these and previous studies, nongenetic yellow phenocopies were not obtained, using α-dimethyl tyrosine, according to the technique described by Burnet, Connolly and Harrison (1973). A yellow female obtained in previous phenocopy experiments produced yellow progeny. She was therefore a mutant, not a yellow phenocopy. Burnet et al. did not report genetic tests on their presumed phenocopies. They did report negative results when wild type Pacific strains of Drosophila melanogaster were tested. On the other hand, we have confirmed part of their results; concentrations of α-dimethyltyrosine in excess of 0.15% reduced fly emergence. A yellow mutator gene appears to be present in the Amherst wild population (Green et al. 1970). Perhaps yellow in flies obtained in phenocopy experiments using Amherst wild stocks (Burnet

et al. 1973) was the result of mutator genes, not phenocopying. In any event, the report of Burnet, Connolly and Harrison (1973) requires clarification.

Drosophila courtship behaviour: The complexity of Drosophila sexual isolation is evident in the complexity exposed by these studies of $X \cdot Y^L$, Y^S, y and spa^{pol} as well as in the work of others. Polygenes on each of the three pairs of chromosomes appear to control sexual isolation in D. paulistorum (Ehrman 1961) and it appears that sexual isolation in genera other than Drosophila is polygene based (Kence and Bryant 1978). Thus the high susceptibility of sexual isolation to genetic change is explained. Change in the amount of assortative mating observed between yellow, wild and translocated stocks, is perhaps the result of change in pheromonal chemistry (Averhoff and Richardson 1976, Ehrmann 1966, Ehrmann 1969, Shorey and Bartell 1970), change in behaviour, or a correlated change in both behaviour and the chemistry of stock sex pheromone. Data on Drosophila behaviour are not sparse (Averhoff and Richardson 1974, Bastock and Manning 1955, Bastock 1956, Bennet-Clark and Ewing 1970, Bennet-Clark et al. 1976, Burnet et al. 1973, Ehrman 1964, Manning 1965, Shorey and Bartell 1970, Spieth 1974, Spieth 1968), and it is generally agreed that the phenotypic expression of behaviour is not independent of genetic background (Bastock 1956). It follows then that consideration of correlated genetic and behavioural changes that vary the sexual isolation between populations, may give some insight into the genetic basis of behaviours, and how behaviours influence selection.

In spite of the voluminous nature of the literature on Drosophila behaviour, reports are still largely descriptive. Terms such as lethargic,

aggressive, and on average are used, and even Mayr(1946) admits to the difficulty in measuring quantitative differences between such remarkably similar rituals displayed by closely related species. However, as Manning (1965) has pointed out, study of the genetics of behaviour really means the study of the genetics of potentiality. With this concept in mind, the genetics of extremely unstereotyped behaviour may perhaps be elucidated, by careful observation. Correlation of genetic and behavioural changes necessitates a description of mutant behaviour, and "it should be a truism that a moderately complete description of an animal's behaviour should contain an account of its patterning in time" (Nelson 1964). That is, the temporal as well as the sequential relationship between behavioural elements should be described (Fagen and Young 1978).

Drosophila mating behaviour is frequently discussed in terms of sexual drive (Spieth 1952) and excitability thresholds (Manning 1965). Some elements of courtship behaviour are considered low intensity elements (tapping, circling) while vibration and licking are treated as higher intensity elements, elicited when the male excitability level is high and approaching a threshold level where the probability of attempted mating is relatively high. No one who has worked with Drosophila, in particular their courtship behaviour, will fail to recognise that the basic repertoire of behaviour elements is common to all closely related species, but the frequency with which these elements are performed appears to differ. The difficulties incurred in measuring these quantitative differences are also well known (Manning 1965). Differences in the frequency with which particular sequencies of behavioural elements are elicited can also be observed in closely related species. For example, the most common sequence

in which tapping (a), orientation (b), scissoring (c), vibrating (d), licking (e) and attempted copulation (f) are performed in the three species of Drosphila melanogaster, simulans and takahashii is a-b-c-d-e-f. It should be noted that melanogaster normally omits scissoring. Another closely related trio of species auria, rufa and montium usually perform in the order, a-b-e-f-d. Note that males of these species actually mount the females before they vibrate their wings (Manning 1955).

Observations of the occurrence probabilities of the sequences of behavioural elements, performed by highly inbred and heavily homogenized T(X-Y), yellow, T(X-Y), y^+ and (X•-Y), y^+ stocks of D. melanogaster suggests that a standard sequence shared by the three stocks, terminating in mating, or attempts to do so, is: male standing approximately directly behind and facing the female (11), male scissoring (12), vibrating (15), licking (16) and abdomen curling and attempted copulation (17 and 20), a sequence not unlike that described above for the first species trio (Manning 1965). As vibration raises sexual excitation of males to a threshold level where licking may be elicited (Bastock 1956), thus it is not unreasonable to suggest that perhaps there are specific thresholds for the elicitation of each element in the standard sequence described above. Interruption of the sequence occurs when performance of any element of behaviour fails to raise the males' sexual excitation to the next theshold level required in order to evoke the behavioural element in the standard sequence. The result is performance of a behavioural element found lower on the excitation threshold ladder. Thus, the unstereotyped behavioural pattern of Drosophila is perhaps explained by thresholds. The mating advantage of T(X-Y), y^+ males over T(X-Y), yellow males with T(X-Y) females

(Table 2, studies 8 and 9), and the sexual isolation observed between stocks, based on the sex chromosome translocation (Table 5), and the sex chromosome translocation-*yellow* allele combination (Table 6, study 2), is perhaps the result of a correlated genetic and behavioural element/sexual excitability threshold change, expressed in a correlated change in the probability of performance of particular sequences of behavioural elements. Such demonstrable behavioural change, based on a sex chromosome change, is not unique; Fraccaro *et al.* (1977) have clearly demonstrated that the polymorphism in mating behaviour in F_1 and backcross males from interspecific crosses between *Anopheles atroparvus* and *A. labranchiae*, is controlled by the Y chromosome. Males carrying *A. atroparvus* Y chromosomes mate spontaneously and singly in cages, while all males bearing *labranchiae* Y chromosomes, mate only in swarms, and necessitate crossing by artificial insemination. In addition, all males which are hybrids for the sex chromosomes, irrespective of their autosomal constituion are sterile, and testicular fertility was demonstrated to be determined by the constitution of the X and Y chromosomes in any one of the species. In *Drosophila*, male courtship rituals, lower females' receptivity thresholds to the point where they spread their and vaginal plates to receive males, and facilitate intromission (Bastock and Manning 1955, Ehrman 1964). In this study, the performance of behavioural elements in a specific sequence is stock (species) specific. Perhaps mating frequency of a given male with a given female is dependent on the frequency of performance of specific sequences of the elements of *Drosophila* courtship rituals. Then T(X-Y),y^+ male mating advantage over T(X-Y),*y* males with T(X-Y),*y* females is explained by a lowered performance frequency of the initial elements of the standard

courtship sequence (standing closely behind the female (11)-scissoring(12)-vibrating (15) . Similarly, sexual isolation based on the sex chromosome translocation is the result of a significant role, attributable to the male vibrating (15), circling the female (19), and licking the female's genitals, in that sequence, in female stimulation.

Further, a volatile sex pheromone produced by females has been reported to stimulate male courtship in D. melanogaster (Shorey and Bartell 1970). Increases in female pheromone results in correlated increases in the frequencies of performance of male behavioural elements. In addition, male courtship behaviour is also stimulated but to a lesser degree by an odour (pheromone) released from other males. Further, female mating frequency has been reported to be affected by olfactory cues issuing from males (Ehrman 1972, 1978). The sex pheromone system in Drosophila appears to be a multicomponent system, such that any of the components, acting alone, even when in relatively large quantities, effect less sexual stimulation than when in smaller quantities and in combination with other components of the pheromone system (Ehrman et al. 1978). Perhaps the sex chromosome translocation brings about a change in the quantity and/or quality of the components of the sex pheromone system in both males and females, such that females prefer males the pheromones of which are similar to their own. Variation in the frequency of performance of particular behavioural sequences is perhaps correlated with variation in the quality, and quantity of the sex pheromone produced by courting males, and the efficiency with which these sex stimulating hormones are received by the females.

$X \cdot Y^L // Y^S$ vs $X \cdot Y^L // Y$ frequency dependent fertility: A newly derived $X \cdot Y^L$ chromosome may become fixed in a finite population (Tracey 1972), perhaps this new $X \cdot Y^L$ chromosome has adaptive potential, not inherent in the ancestral X. For example, Neanura monticola (collembdan) in the Pyrenees show five types of X-chromosomes, each adapted to either damp conditions and low elevation, cold and higher elevations, or subalpine conditions (White 1978). Similarly the Arrowhead third chromosome inversion in Drosophila pseudoobscura is fitter at temperatures of 16°C as opposed to 25°C (Ehrman 1966). In any event, once fixed, the duplicated Y^L segment on the Y chromosome of $X \cdot Y^L // Y$ males may be lost by accumulation of deletions (Lucchesii 1978), or a recurrence of a similar X-Y translocation (Yoon and Richardson 1977), without a correlated loss of fitness to $X \cdot Y^L // Y^S$ males. These Y^S bearing males have a higher relative fertility with $X \cdot Y^L // X \cdot Y^L$ females than $X \cdot Y^L // Y$ males (Table 10 and 11, and Figure 6). At relatively low Y^S frequencies, when Y^S bearing males are in competition with Y bearing males for $X \cdot Y^L // X \cdot Y^L$ females , the average fitness of $X \cdot Y^L // Y^S$ males is relatively high (Mather 1969). Subsequently the Y^S chromosome increases, reducing the frequency of Y bearing males in the population, the average fitness of Y^S bearing males and a correlated reduction in the Y^S selection coefficient. At relatively high Y^S frequencies, $X \cdot Y^L // Y^S$ males are essentially in competition with individuals with genotypes similar to their own, and the Y^S selection coefficient approaches its calculated maximum. This frequency dependent competitive selection would lead to rapid fixation of the Y^S chromosome in a finite population with the result that the population becomes monomorphic for the sex chromosome translocation.

The Y^S change is positive at frequencies below 0.98 (Table 10). This is suggestive of a possible stable Y-Y^S polymorphism of around 0.97. Such a polymorphism may have significance to the fitness of the population in the event the Y^L segment is lost from the X·Y^L chromosome (Muller 1949 cf Tracey 1972), since X·Y^S males are sterile. As the Y^S frequency approaches 0.95 its calculated selection coefficient (s) approaches zero (Figure 5). The maximum value for s is also near zero at high Y^S frequencies. Nevertheless, the selection coefficients for the Y^S chromosome at high Y^S frequencies remains below its maximum value, and becomes slightly negative rarely. These small negative values are perhaps due to the closeness of the selection coefficients to zero, and small sampling errors.

A simple genetic model of speciation: Having surveyed the effects on hybrid sterility and sexual isolation of a particular sex chromosome translocation, and its interaction with marker alleles, an allopatric model of speciation initiated by such a sex chromosome translocation is not difficult to accept. The model is simple (see Figure 6).

1. A sex chromosome translocation occurs within an isolated gene pool, such that the long arm of the Y chromosome becomes attached to the X, creating an X·Y^L factor, and a small centric Y^S fragment, lacking fertility factors (Stern 1929).
2. The X·Y^L derived X chromosome becomes fixed in the population (Tracey 1972).
3. The duplicated Y^L segments in X·Y^L//Y males is lost without loss in fitness to X·Y^L//Y^S males.

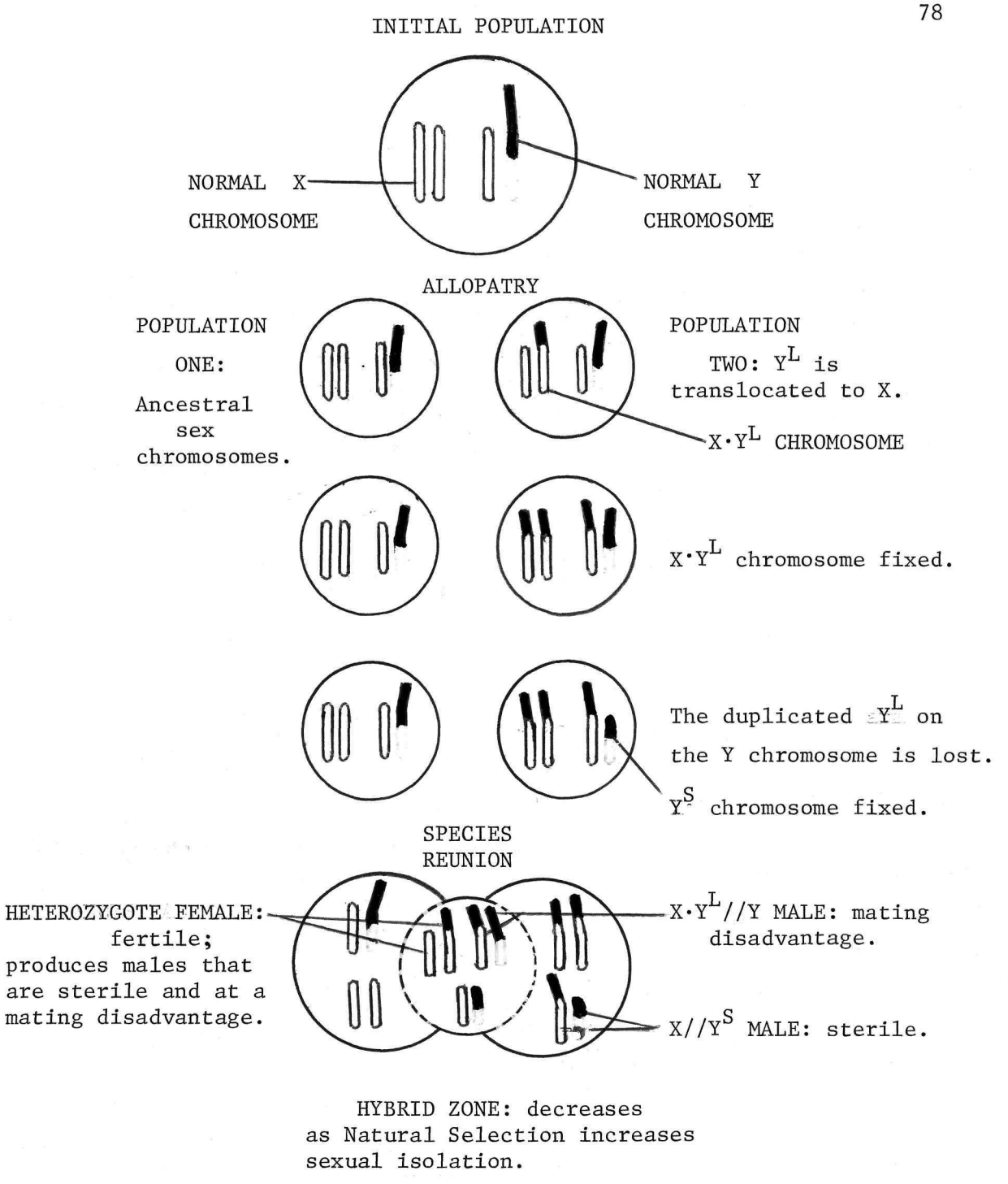


Figure 7. Simple model of speciation by a sex chromosome translocation: A sex chromosome translocation occurs in a founder population. The $X \cdot Y^L$ is fixed. A subsequent loss of the Y^L segment, and fixation of the Y^S fragment, results in a T(X-Y) population that is sexually isolated from the ancestral one. In a sympatric situation, Natural Selection acts to decrease the production of hybrids, which are less fit than the two parental types

4. $X \cdot Y^L // Y^S$ males have a mating advantage over $X \cdot Y^L // Y$ males with $X \cdot Y^L // X \cdot Y^L$ females (Tracey and Espinet 1976). The Y^S chromosome is fixed in the population by frequency dependent competitive selection (Figure 5).
5. The sex chromosome translocation effects a change in the sequence in which the elements of courtship behaviour are performed (see Figure 8, study 2, element 19 "circling").
6. In renewed sympatry, the sex chromosome translocation bearing population is sexually isolated from the ancestral one, merely as a byproduct of the chromosomal rearrangement.
7. Heterogametic matings between $X \cdot Y^L // X \cdot Y^L$ females x X//Y males give rise to $X \cdot Y^L // Y$ males which are at a mating disadvantage with either X//X or $X \cdot Y^L // X \cdot Y^L$ females. Heterogametic matings in the opposite direction give rise to sterile $X // Y^S$ males. $X // X \cdot Y^L$ heterozygotic females produce both sterile males, and males with decreased fertility.
8. Natural selection should act to eliminate the production of the hybrids, by strengthening both pre- and post-mating isolation. Thus both ancestral and derived species should move along the continuum of reproductive isolation to becoming morphologically distinguishable species.
9. As derived $X \cdot Y^L // X \cdot Y^L$ female preference for $X \cdot Y^L // Y^S$ increase, frequency dependent competitive selection would act to maintain and stabilize the $X \cdot Y^L$, Y^S, X and Y polymorphism.

The present model differs from the classical one proposed by Mayr (1963) in that both heterogametic hydrid sterility and sexual isolation appear as an effect of a sex chromosome translocation, and not the result of adaptive divergence due to the accumulation of allelic changes under specific selection pressures.

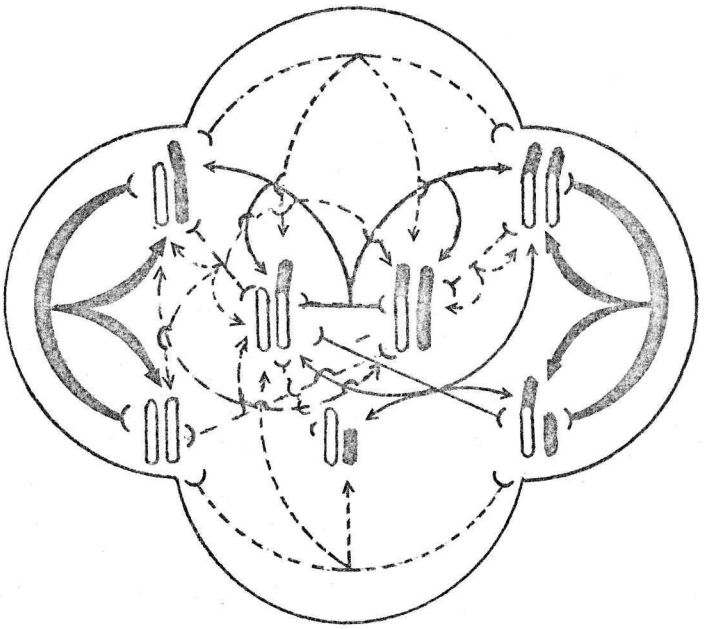
Some further considerations of the basic T(X-Y) model of speciation: Estimation of fertility and viability show that heterozygous $X^{\bullet}//X\cdot Y^{L}$ and $X//X\cdot Y^{L}$ females are fitter than homozygotes when Y chromosomes are wild type (Tracey 1972), the overdominance observed was most probably due to inversions. This possible overdominance of heterozygotes implies that their mate preference may play a significant role in karyotype frequency change in populations polymorphic for X, $X\cdot Y^{L}$, Y and Y^{S} chromosomes. $X\cdot Y^{L}//X$ hetero ygotes prefer $X\cdot Y^{L}$ bearing males, irrespective of their Y chromosome (Table 8 study 2). The implication is that the T(X-Y) sub-population would increase. The answer to the question, "do $X\cdot Y^{L}//Y$ males enjoy a mating advantage over $X//Y$ and $X\cdot Y^{L}//Y^{S}$ males when females are heterozygous $X//X\cdot Y^{L}$?" is pending experimental observation. Nevertheless, considering the Y^{L} duplication in $X\cdot Y^{L}//Y$ males, and the evidence that enzymes coded by X-linked genes show twice the activity per gene dose in males (Lucchessi 1978), it is not unreasonable to assume that Y^{L}-linked gene activity doubles, or perhaps triples if the effect of dosage compensation on X-linked genes spreads to the Y^{L} segment borne on the X-chromosome. In addition, perhaps genes of this segment, normally unexposed, are turned on when the Y^{L} is translocated to the X. The latter suggestion appears feasible, since in D. miranda, an autosomal arm (C element) translocated to the Y, is degenerating (Lucchesi 1978). Perhaps relocation of heterochromatic segments of the Y chromosome to activated chromosomes, activates Y-linked genes which normally lie dormant, or position effect Y^{L} heterochromatin produces variegation of X genes near the breakpoint. In any event, the $X\cdot Y^{L}//Y$ males appear to have a less well integrated genome than either $X//Y$ or $X\cdot Y^{L}//Y^{S}$ males with $X\cdot Y^{L}//X\cdot Y^{L}$ females.

Perhaps these $X \cdot Y^L // Y$ males have a similar fitness relationship with $X // X \cdot Y^L$ females.

In any event, $X \cdot // X \cdot Y^L$ and $X \cdot Y^L // X$ heterozygote females have the potential to produce sterile sons if mated to Y^S bearing fertile males. On the other hand, F_1 female matings to Y bearing males, produce $X \cdot Y^L // Y$ males 50 percent of the time. These appear to be at a disadvantage with either $X \cdot Y^L // Y^S$ or $X // Y$ males for mates. Selection should act to decrease such unfit male production, perhaps through decreased interbreeding of homokaryotypes (see Figure 8).

Behavioural elements may be added to the $X \cdot Y^L // Y^S$ male mating ritual, through selection of alleles such as yellow, which changes the male mating pattern by decreasing vibration bout rate and reducing the frequency with which males perform the initial elements in the sequence of their courtship ritual (results presented in this thesis). This, together with increased $X \cdot Y^L // X \cdot Y^L$ female discrimination, would give rise to increased positive assortative mating (Table 6, study 2). Such positive assortative mating, coupled with mating speed results in an increased overall sexual isolation (Kence and Bryant 1978), to the level where the production of hybrids is reduced. In this case, $X\underline{y}^+ // X \cdot Y^L \underline{y}$ F_1 females would exhibit a preference for $\underline{y}^+$ bearing males (Table 8, studies 1a, 3a and 4a). Note that $X\underline{y}^+ // Y^S$ males are sterile and selection should decrease this sterile male mating advantage. Then $X\underline{y}^+ // Y$ males would become the preferred male (see Table 8, studies 1b, 3b and 4b), and the (X-Y) sub-population would increase. Even so, 50% of the F_1 males from these $X\underline{y}^+ // X \cdot Y^L$ female x $X\underline{y}^+ // Y$ male preferred matings would be $X \cdot Y^L // Y$, with reduced fitness. Therefore, selection could further decrease heterozygote production by increasing positive assortative matings

A: Sexual isolation consequential of a sex chromosome translocation.



B: Sexual isolation as a result of Natural Selection against hybrib production.

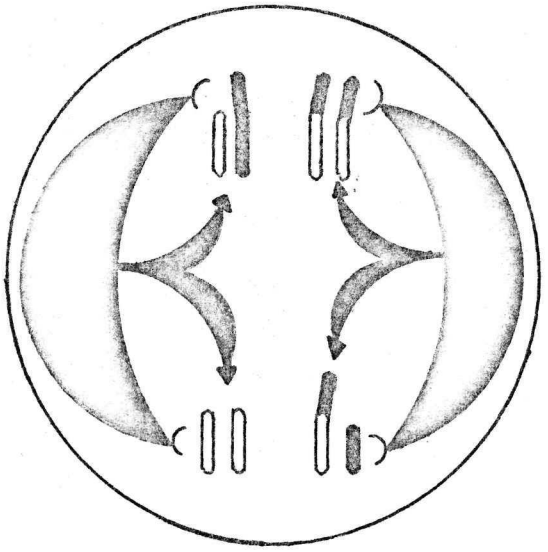


Figure 8. Mating frequency between individuals of a population which is polymorphic for X,Y,X.Y^L and Y^S chromosomes. Solid lines join each female to the male of her choice. The arrows indicate the progeny resulting from each cross. The thickness of the line in each cross is relative to the frequency in which it occurs in the population. Heterozygotic females prefer X·Y^L b bearing males. 50% of these crosses result in males that are sterile or at a mating disadvantage. Natural Selection eliminates hybrid production by increasing homogametic matings.

between homokaryotypes. At this stage, any drop in male frequency from either population would result in an added increment to their fertility through frequency dependent competitive selection (Mather 1969, O'Donnald 1978). The X, $X \cdot Y^L$, Y and Y^S polymorphism may stabilize and reproductive isolation might be completed under sympatric conditions.

"Nothing in biology makes sense except in the light of evolution." (Dobzhansky et al. 1977). The very essence of evolution is variation. Thus it operates along a variety of planes in various groups or organisms. Often debates among biologists have no unequivocal answer (Fredga 1977). One such debate still surrounds the question of whether chromosomal changes are a cause or effect of speciation. The karyotype variations that characterise extant species are tremendous (Fredga 1977). Within the D. virilis group, D. ezoana, littoralis montana and lacicola all bear distinct X chromosomes that have undergone such enormous amounts of restructuring that precise analysis on them has never been carried out (White 1978). In addition, D. montana ♀ ♀ x D. littoralis ♂ ♂ result in all male sterile F_1 progeny. In the reciprocal cross, females are fertile. Further D. littoralis ♀ ♀ x D. lacicola ♂ ♂ produce fertile females and sterile males, but sterile progeny from the reciprocal cross. Evidently, rearrangements involving the sex chromosomes are particularly good candidates for the interruption of gene flow through a population. They have obviously played a significant role during the speciation of Simulids and Chironomids (White 1978).Thus there is unmistakable evidence that chromosomal rearrangements have played a role in organismal evolution (Fredga 1977). Perhaps such macromutations affect gene regulation, especially during development, and are the keys to the "missing links" in the evolution of higer taxa.(Valentine and Campbell 1975).

SUMMARY

Drosophila melanogaster populations, that are monomorphic for an $X \cdot Y^L$ and Y^S chromosomes, produce sterile F_1 hybrid males, when $X \cdot Y^L // Y^S$ males are crossed with normal females. Hybrids of the heterogametic sex from 100 out of 101 interspecific crosses in *Drosophila* are sterile (Ehrman 1962).

Sexual isolation between a sex chromosome translocation bearing stock marked with *yellow* and a wild karyotype stock marked with *sparkling*^{poliert} was observed to be at a level above that found for subspecies of *D. willistoni* (Tracey and Espinet 1976). The thesis reports the result of:

1. a survey of this sexual isolation, with respect to marker allele and karyotypic effects, on mating frequency and mating behaviour.
2. a test of a frequency dependent fitness relationship of Y^S bearing males and sex translocation bearing females.
3. a survey of heterozygotic female mating frequency with homozygous and heterozygous males, on karyotype frequency change in a population polymorphic for X, X·Y, Y and Y^S sex chromosomes.

The *sparkling*^{poliert} marker reduces male activity.

The *yellow* allele also appear to affect activity and reduces the frequency with which the elements of the sequence of events, in the male courtship behaviour are performed, relative to the later elements. In addition, this marker effects asymmetric sexual isolation, and a positive *y* and T(X-Y) interaction is apparent.

The sex chromosome translocation seems to result in the incorporation of circling, between vibration and licking during the male behavioural repertoire. The fitness of Y^S in a population monomorphic for $X \cdot Y^L$ follows a frequency dependent selection model, and there is sexual isolation between the $X \cdot Y^L$, Y^S and X, Y populations.

The applicability of these results to evolutionary theory is discussed.

"It is the great beauty of our science that advancement in it, whether in a degree great or small, instead of exhausting the subject of research, opens the doors to further and more abundant knowledge, overflowing with beauty and utility."

Michael Faraday

Future experiments: Sexual isolation between $X \cdot Y^L$, Y^S and X, Y flies Evidently sexual isolation, and its evolution, are indeed complex; its susceptibility to change is high and correlated to genetic change. Sexual isolation was observed between $X \cdot Y^L$, Y^S and X, Y flies in five genetic backgrounds. Positive assortative mating was clear in yellow populations where the X was normal Multiple choice mating chamber studies, of wild bodied flies, where the X is wild type, would give more information on the amount of sexual isolation between sex chromosome translocation and wild karyotype flies.

2. Heterozygote mate preference, and karyotype frequency change: Observation of the mating frequency, between individuals that are homokaryotypic and heterokaryotic for the sex chromosome translocation are relevant to establishing the changes in chromosome frequency in a population polymorphic for X, $X \cdot Y^L$, Y and Y^S chromosomes. Present studies employed male choice experiments. It is intended that mating chamber studies, where each female is given a choice of four genotypically distinct males, and each male is offered females of the three possible genotypes would be preformed. Such an experiment would provide a base for the discussion of the relevance of a sympatric model of speciation by a sex chromosome translocation.

3. Sex Chromosome translocation and behavioural alterations: Preliminary studies suggest that the primary difference between normal X, Y flies and $X \cdot Y^L$, Y^S flies is an extension of the event circling and its incorporation between vibration and licking. Unfortunately, the work is very time consuming, and the results tediously analysed. Thus, our sample sizes were small. Confirmation of these behavioural studies and extension to

different types of rearrangements is necessary to establish the generality of the effect. Data processing programs will be written to analyze two, three and four dimensional matrices of courtship elements. Input data for these analyses will be magnetic tapes upon which the courtship sequences had been recorded by means of telephone touch-tone pads.

4. Selection for increased sexual isolation between X, Y and $X \cdot Y^L$, Y^S stocks: It has been shown that hybrids produced from crosses made between X, Y and $X \cdot Y^L$, Y^S stocks are less fit than the parental stocks. Therefore the prediction that natural selection would act to decrease production of these hybrids, through increased sexual isolation was made. To test this hypothesis, population cage experiments would be initiated containing equal frequencies of the X, Y stock marked with vestigial wings and $X \cdot Y^L$, Y^S stock marked with apterous wings. Winged heterozygotes would be eliminated as they produced, and the change in sexual isolation between the two stocks would be observed. In addition, observation of the relative increases in homokaryotypic matings is expected to be greater in $X \cdot Y^L$, Y^S populations, accord to the hypothesis:

the chromosomal rearrangement creates new genetic potential for adaptation through position effects.

GLOSSARY OF KARYOTYPES

1. X: Normal or wild type X chromosome

2. $X \cdot Y^L$: An X chromosome to which the long arm of the Y chromosome has been translocated, and attached at the centromeric end of the X.

3. X•: An X chromosome that once carried a Y^L attachment. The Y^L segment was removed by recombination.

4. Xy: A wild type X chromosome bearing a yellow mutation.

5. Y: A wild type Y chromosome.

6. Y^L: The long arm of the Y chromosome

7. Y^S: The short arm of the Y chromosome. It bears the centromere

8. $Y^S y^+$: The short centric Y chromosome fragment which bears the wild allele of the yellow locus

9. X//Y,y: Normal karyotype male, with a yellow marker.

10. T(X-Y): A translocation involving the X and Y chromosomes.

11. X-Y: Normal X and Y chromosomes.

12. X, Y: Normal X and Y chromosomes.

13. $X \cdot Y^L$, Y^S: Sex chromosome translocation X and Y chromosomes.

14. (y)(T(X-Y): Interaction between the yellow marker and the translocation involving the X and Y chromsomes.

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Appendix A

Recipes, Behavioural Elements

Selection Coefficients and Extraction Schemes

Table A1. Ingredients for culture medium

1. 1350 ml molasses
2. 8650 ml H_2O
3. 1030 g wheat-lets (cream of wheat)
4. 100 ml tegosept
5. 70 g NaCl
6. yeast (vials containing culture media were misted with brewer's yeast in liquid culture).

Table A2. Basic components of standard test medium C. Oxoid Ionagar No. 2 was substituted for Oxoid, Kobe No. 1. The weights of α-dimethyl tyrosine added to basic components to produce phenocopy media of various concentrations of α-DMT are given in the last line.

Compound	Weight (g)
Agar (Oxoid Ionagar No. 2)	3.00
Casein	5.50
Fructose	0.75
Cholesterol	0.03
Lecithin	0.40
Yeast nucleic acid	0.40
Thiamine	0.0002
Riboflavin	0.0010
Nicotinic acid	0.0012
Calcium pentothenate	0.0016
Pyridoxine	0.00025
Biotin	0.000016
Folic acid	0.0003
$NaHCO_3$	0.140
KH_2PO_4	0.183
Na_2HPO_4	0.189
Water to	100 ml
α-DMT	0.3, 0.15, 0.075, 0.038, 0.0

Table A3. Male and female elements of behaviour.

1. ♀ walking
2. ♂ walking
3. ♀ preening
4. ♀ attempted flying
5. ♂ attempted flying
6. ♀ hopping
7. ♀ abdomen lowering
8. ♀ flying
9. ♀ proboscis extending
10. ♀ ovipositor protrusion
11. ♂ standing 1 mm directly behind female
12. ♂ scissoring
13. ♂ preening
14. ♂ following female
15. ♂ vibrating
16. ♂ licking female genitals
17. ♂ abdomen curling
18. ♂ and ♀ tapping
19. ♂ circling
20. ♂ attempted copulation

Table A4. Selection coefficients (s) for the Y^S chromosome at various frequencies. The Y^S frequency change for each generation is given in parentheses. Values were calculated by solving $s = 1 - (q_{t+1})/q_t$, using the cage data from Table 10 and Tracey (1972)*, and by setting $q_{t+1} = 1$ for various q_t's (s_{max}).**

Generation:	0-1	1-2	2-3	3-4	4-5	5-6	6-7
1	(0.99-0.982) 0.0081	(0.982-0.969) 0.0132	(0.969-0.98) -0.0114				
2	(0.75-0.771) -0.028	(0.771-0.938) -0.215	(0.938-0.98) -0.0459				
3	(0.5-0.788) -0.578	(0.788-0.938) -0.189					
4[1]	(0.5-0.765) -0.53	(0.75-0.894) -0.192	(0.99-0.998) -0.008				
5*	(0.5-0.84) -0.68	(0.84-0.88) -0.0476	(0.88-0.92) -0.0455	(0.92-0.885) 0.0389	(0.885-0.93) -0.0508	(0.93-0.94) -0.0107	(0.94-0.927) 0.0138
6*	(0.5-0.86) -0.72	(0.86-0.95) -0.1046	(0.95-0.92) 0.0316	(0.92-0.95) -0.0326	(0.95-0.987) -0.0389	(0.987-0.99) -0.003	(0.99-0.98) 0.0102
Generation:			7-8	8-9	9-10	10-11	11-12
			(0.98-0.977) 0.0031	(0.977-0.987) -0.0102	(0.987-0.978) 0.0091	(0.978-0.97) 0.0082	(0.97-0.987) -0.0175
7**	(0.50-1.00) -1.00	(0.56-1.00) -0.786	(0.62-1.00) -0.613	(0.68-1.00) -0.471	(0.74-1.00) -0.351	(0.80-1000) -0.250	(0.86-1.00) -0.163
	(0.92-1.00) -0.087	(0.98-1.00) -0.020	(0.99-1.00) -0.010				

[1]Selection coefficients calculated from female mating frequency to Y^S bearing males, at different Y^S frequencies (see Table 11 and connecting text).

Figure A1. Scheme for outcrossing T(X-Y)*yell*, T(X-Y)y^+ and *sparkling poliert* (*p*//*p*) laboratory stocks, to a wild strain of *Drosophila melanogaster*. T(X-Y) chromosomes are *y f car*·Y^L(X·Y^L) and Y^S, with y^+,Y linked. Three isofemale lines of the wild strain were employed in initial crosses. Steps taken in outcrossing stocks were as follows:

Step 1. Initial crosses.

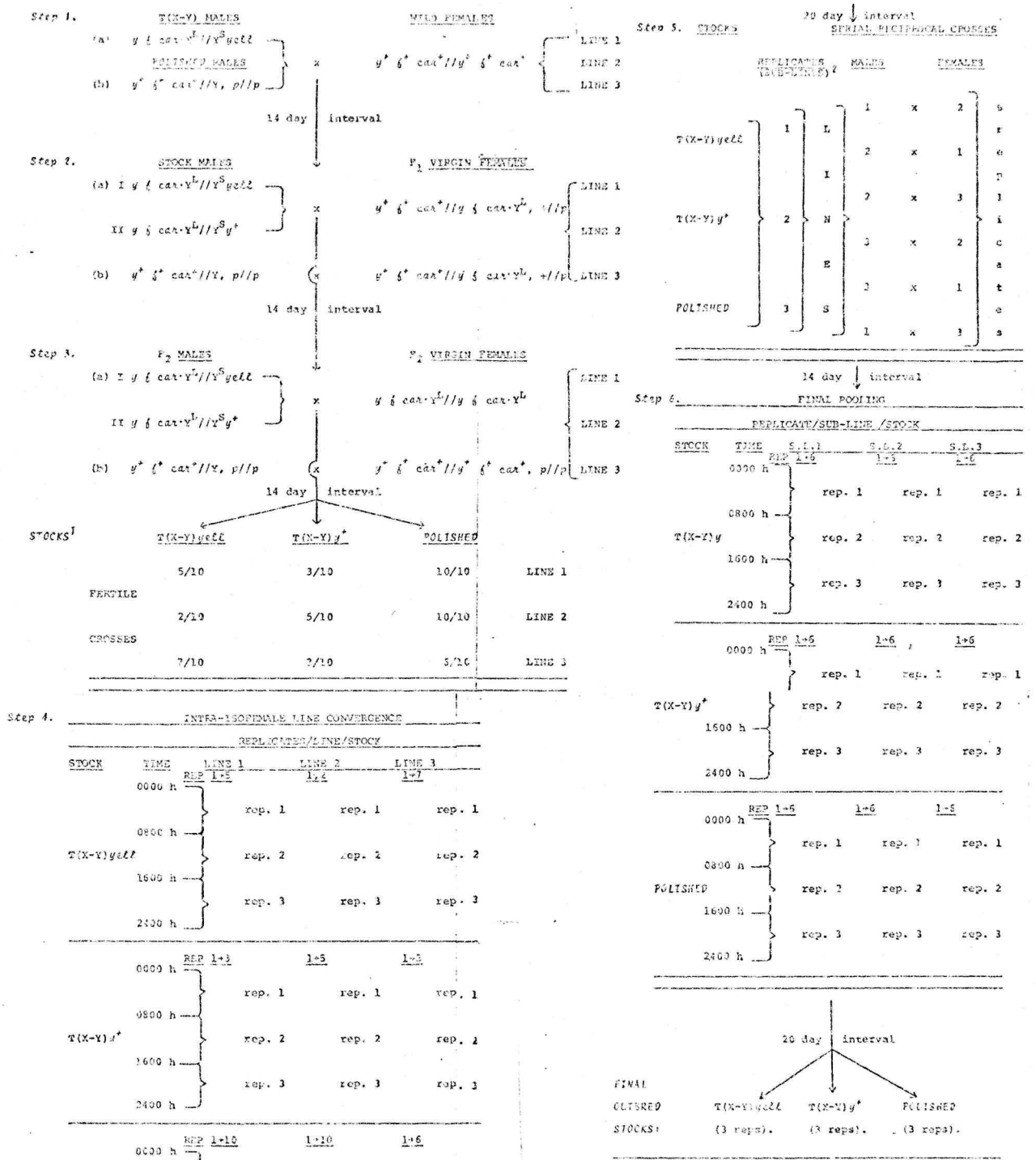
Step 2. Ten single pair matings per isofemale line in backcrosses, in order to produce homogametic males and females.

Step 3. Ten replicates per isofemale line in preparation of homokaryotypic lines.

Step 4. Intraisofemale line convergence: Eight-hour old progeny from each replicate/line/stock were pooled sequentially in three replicates (mass cross).

Step 5. Isofemale line convergence: Eight-hour old progeny were reciprocally and serially crossed by line and stock (chain cross).

Step 6. Final pooling: Eight-hour old progeny from chain cross were mass crossed as in Step 4 in order to produce three replicates per final outbred stock.



[1] Recombination of X//X·Y^L in step 2 produced y+ (y f car.) X chromosomes lacking Y^L segments, which, when combined with Y^S in step 3 (a), resulted in sterile males. Four out of ten p//p replicates of line 3 were destroyed by *penicillium* infection.

[2] The three replicates per stock, generated in step 4, were classified sublines in step 5.

Figure A2. Crossing scheme followed in order to: (1) Standardize the genetic background of sparkling poliert (X//X, p//p), T(X-Y)yell and y^+ Drosophila melanogaster stocks (stocks 2, 7 and 9 of Table 1); and (2) Produce X//Yyell, T(X-Y)yell and y^+ sparkling poliert stocks (stocks 3, 8 and 10 of Table 1). T(X-Y) chromosomes and $X \cdot Y^L$ (y f car) and Y^S or $Y^S y^+$. Parenthesized numbers indicate parental stocks of individuals as noted in Table 1. Crosses (a) to (m) were carried out in replicates of 40 single pair matings. Steps taken in crossing scheme were as follows:

Step 1. Initial crosses carried out in three lines (See Fig. A1, final outbred stocks).

Step 2. Backcrosses to produce males and females homogametic for their sex chromosomes, and homo- and hetero- zygotic for sparkling poliert. Crosses (c) to (f).

Step 3. F_2 intercrosses (g) to (l) in preparation of homokaryotypic and zygotic individuals.

Step 4. I Preparation of stocks 2, 7, 8, 9 and 10 of Table 1 by intercrossing individuals produced in Step 3, in crosses (m) to (r).

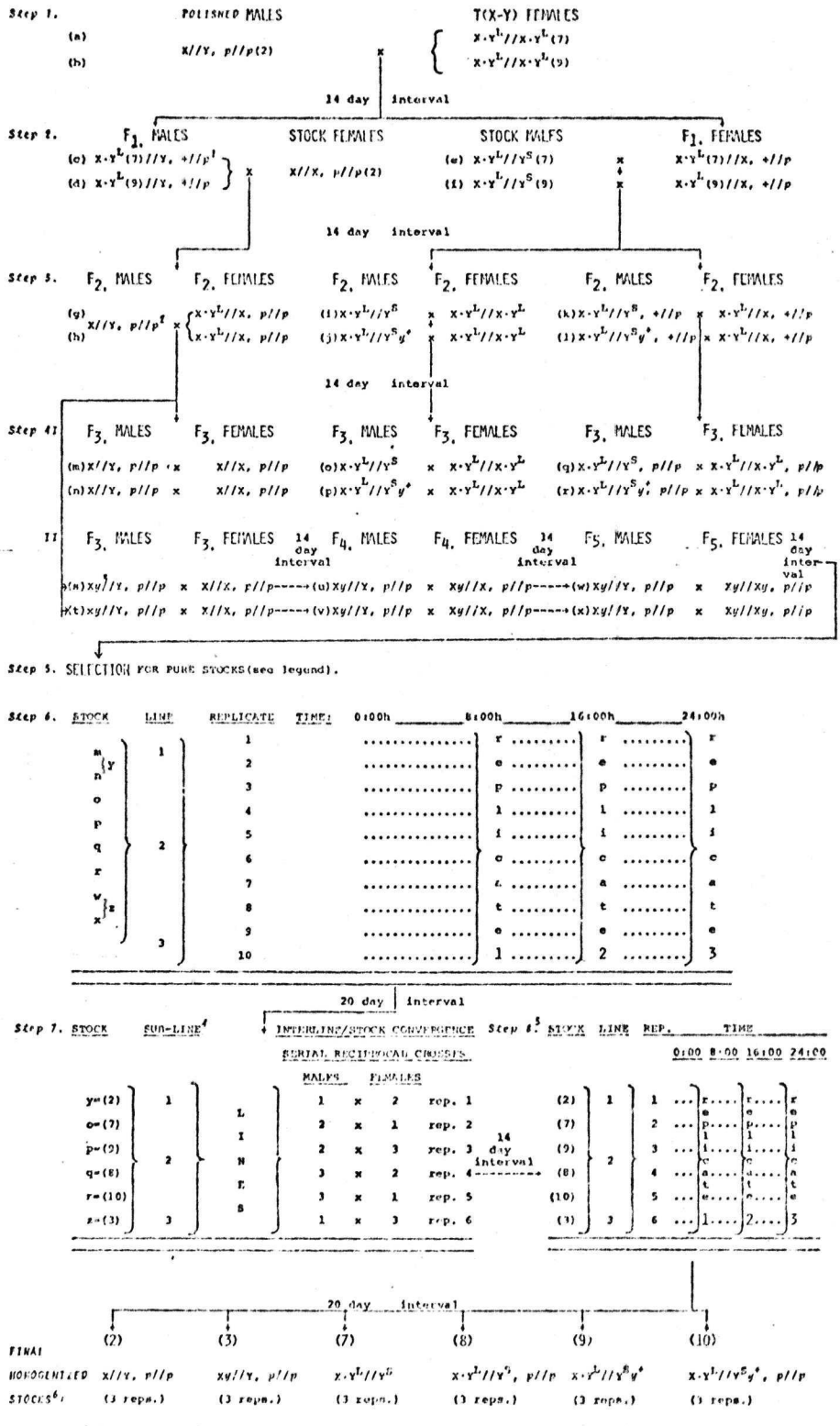
Step 4. II Preparation of stock 3 of Table 1. Yellow, sparkling poliert males produced from crosses (k) and (l) were crossed to their sisters in (s) and (t) in order to produce yellow, sparkling poliert males and females which were crossed in (w) and (x) to produce stock 3.

Step 5. Purification of stocks by selection: Three to four generations of selection for pure phenotypic expression, using crosses identical to m, n, o, p, q, r, u and v, involving five pairs of individuals (with phenotypic expression closest to that expected), until 10 replicates of each cross showed good phenotypic expression in all progeny for two consecutive generations. Replicates that continued to show variegation were discarded (56-day interval to step 6).

Step 6. Intraline/stock convergence by mass crossing: Eight-hour old progeny from each replicate/line/stock were pooled sequentially in three replicates. Duplicated lines (m) and (n), and (w) and (x) were combined and noted (y) and (z) respectively.

Step 7. Interline/stock convergence: Eight-hour old naive males and virgin females from each of the three replicates per three lines were reciprocally and serially crossed, resulting in six sub-lines/stock (chain cross).

Step 8. Final pooling: Eight-hour old progeny from chain cross, mass crossed as in Step 6, resulting in three final replicates of stocks 2, 3, 7, 8, 9 and 10 of Table 1 and Figure 2.



[1] Heterozygotes +//p showed variegation in expression of ommatidia. Phenotypes ranged from very pearly and patchily developed ommatidia, with colour variation of scarlet to deep wine, and a glazed appearance, to near wild, mainly eye slightly glazed. The deep wine coloration was concentrated in the frontal section of the eye.

[2] Individuals with phenotypic expressions closest to expected, were utilized in crosses.

[3] Xy was produced by recombination of X·Y^L//X, p//p, in step 3.

[4] The three replicates per stock generated in step 6, were denoted sub-lines in step 7.

[5] See step 6.

[6] Stocks are denoted by their male genotypes. Numbers in parentheses indicate order of stock, listed in Table 1.

Figure A3. Crossing scheme to produce X•/Y, $\underline{y}^+$ Drosophila melanogaster stocks (Stock 4 of Table 1). Double crossover progeny, $\underline{y}^+$ f car•, were recovered from F_1 females of Appendix A, Figure A1, Step 1. Y chromosomes were obtained from X•Y^L//Y stocks (Tracey and Espinet 1976). Parenthesized Y^L's represent the possible presence of the Y^L segment. $\underline{Y}^+$ f car• (X•) chromosomes were identified by the sterility of X•//Y^S males. Crosses were initiated in replicates of 80 single pair matings. Steps taken in crossing scheme were as follows:

Step 1. As Appendix A, Figure A1, Step 2: Recombination events required between the markers, y and f, and car and Y^L, respectively. (Lines were not distinguished.)

Step 2. F_2 females were crossed to X•Y^L//Y males (Tracey and Espinet 1976).

Step 3. F_3 intercrosses between $\underline{y}^+$ marked individuals in order to produce homozygous $\underline{y}^+$ females.

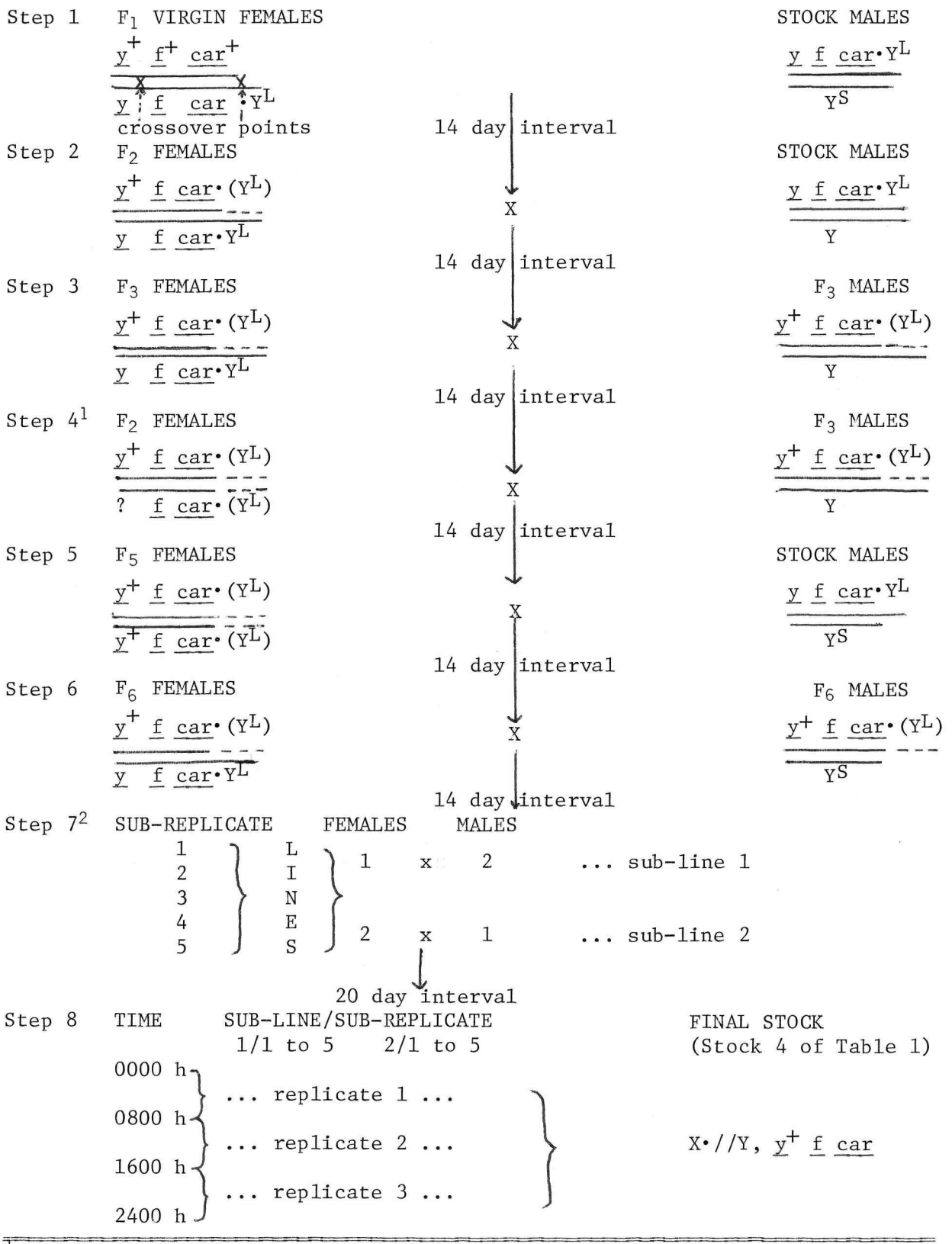
Step 4. Backcrosses, to identify $\underline{y}^+$ homozygous females.

Step 5. Production of X•//Y_S males: (Five sub-replicates of single pair matings, per initial replicate).

Step 6. Identification of $\underline{y}^+$ f car• (X•) chromosome: Two sub-replicate sets of crosses were sterile; they contained X•//Y^S males.

Step 7. Inter-replicate convergence: Eight-hour old progeny were crossed reciprocally by replicate and sub-replicate (chain cross).

Step 8. Final pooling: Eight-hour old progeny obtained from chain cross were mass crossed; pooled sequentially into three replicates of stock.



[1] 47 crosses which produced yellow progeny were discarded.

[2] 75 siblings from replicates which produced sterile males employed in Step 6 were used to produce final stock

Figure A4. Crossing scheme to produce X•//Y, y Drosophila melanogaster stocks (Stock 5 of Table 1). Single crossover progeny, y f car•, were recovered from X•Y^L//X females back crossed to X//Y males. Wild chromosomes were obtained from (Demspey 1976). X• was identified by sterility of X•//Y^S males. The number of replicates per single pair cross is given in parentheses following each cross.

Step 1. Females of a yellow T(X-Y) stock (Tracey and Espinet 1976) were outcrossed to males of a wild strain.

Step 2. F_1 females were backcrossed to recover single crossover progeny, y f car•.

Step 3. Yellow males were crossed to Basc females which contained X chromosomes bearing an inversion. (Parenthesized Y^L indicates the possible absence of the Y^L segment).

Step 4. Production of y f car•//Y^S males.

Step 5. Identification of y f car• (X•) chromosome: three of 125 crosses were sterile.

Step 6. Production of y f car•//Y males: F_3 female sibs from replicates which produced sterile males were crossed to basc males.

Step 7. Production of y f car• homozygous females: 32 replicates containing homozygous y^+ females were discarded.

Step 8. Production of y f car•, Y lines: sequential intercrossing of y f car• progeny from remaining 13 replicates.

Step 9. Final pooling: Eight-hour old progeny from 7 replicates produced from sequential cross, mass crossed, in order to produce three replicates of final stock.

Step 1 P_1 MALES

$\frac{y^+\ f^+\ car^+}{Y}$

Step 2 P_1 MALES

$\frac{y^+\ f^+\ car^+}{Y}$

Step 3 F_2 MALES

$\frac{y\ f\ car\cdot(Y^L)}{Y}$

Step 4 STOCK MALES

$\frac{y\ f\ car\cdot Y^L}{Y^S}$

Step 5 F_4 MALES

$\frac{y\ f\ car\cdot(Y^L)}{Y^S}$ - - -

Step 6 F_3 BASC MALES

$\frac{y^+\ f^+\ car^+}{Y}$

Step 7 F_5 MALES

$\frac{y\ f\ car\cdot}{Y}$

Step 8 F_6 MALES

$\frac{y\ f\ car\cdot}{Y}$

1
LINES 3
5
7
9
11
13

P_1 FEMALES

$\frac{y\ f\ car\cdot Y^L}{y\ f\ car\cdot Y^L}$ (5)

14 day interval

F_1 FEMALES

X $\frac{y^+\ f^+\ car^+}{y\ f\ car\cdot Y^L}$ (25)x(5)

recombination

14 day interval

BASC FEMALES

X $\frac{y^+\ f^+\ car^+}{y^+\ f^+\ car^+}$ (25)x(5)

14 day interval

F_3 FEMALES

X $\frac{y\ f\ car\cdot(Y^L)}{y^+\ f^+\ car^+}$ - - - (25)x(5)

14 day interval

F_4 FEMALES

X (VIRGINS) (25)x(5)

14 day interval

F_3 FEMALES

X $\frac{y\ f\ car\cdot}{y^+\ f^+\ car^+}$ (3)x(5)

14 day interval

F_5 FEMALES

X
1. $\frac{y\ f\ car\cdot}{y^+\ f^+\ car^+}$
2. $\frac{y^+\ f^+\ car^+}{y^+\ f^+\ car^+}$ (15)x(3)

14 day interval

F_6 FEMALES

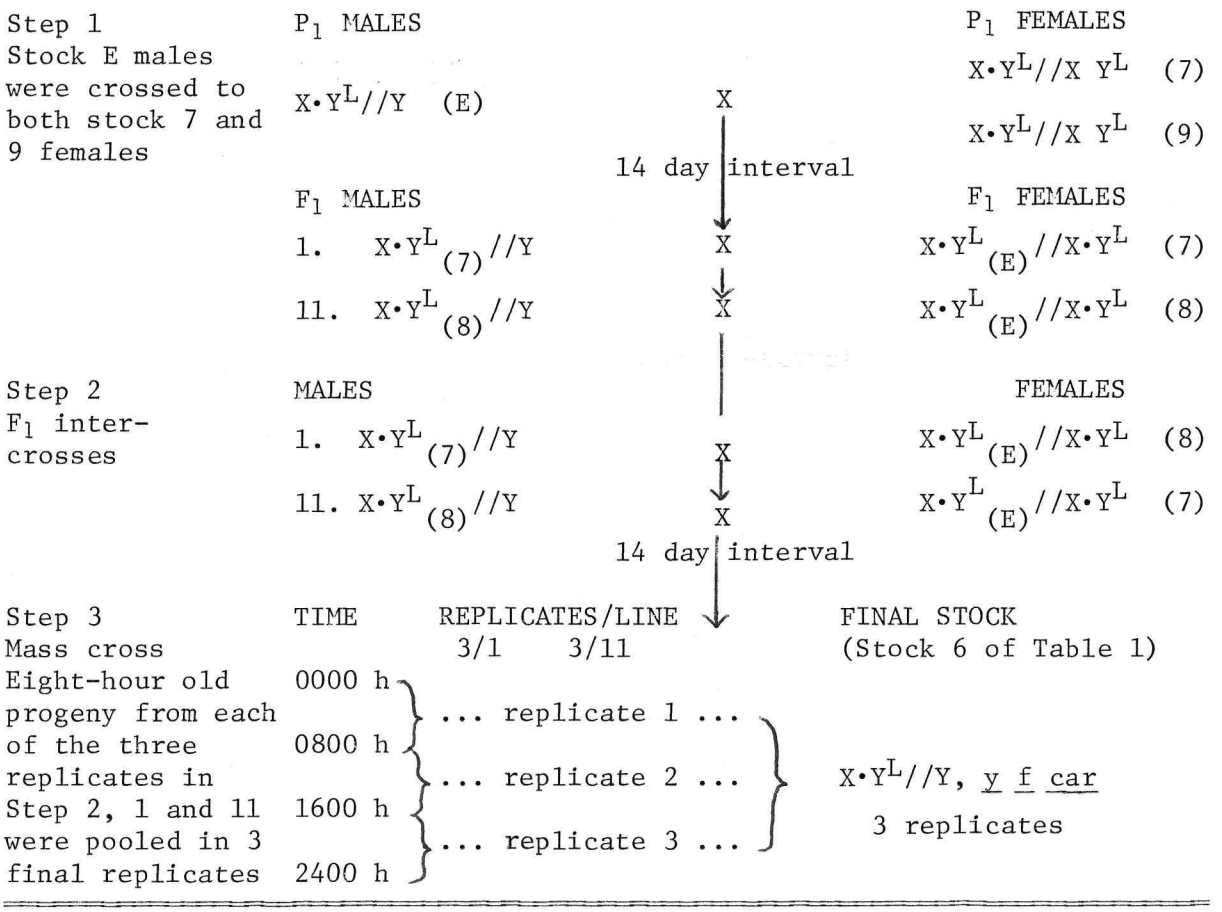
$\frac{y\ f\ car\cdot}{y\ f\ car\cdot}$ (7)

X 2
X 4
X 6
X 8
X 10
X 12
X 14

Step 9

TIME	REPLICATES 1 2 3 4 5 6 7	FINAL STOCK (Stock 5 of Table 1)
0000 h 0800 h	... FINAL REPLICATE 1 ...	X·//Y, y f car·
1600 h 2400 h	... FINAL REPLICATE 2 ...	
	... FINAL REPLICATE 3 ...	

Figure A5. Crossing scheme to produce X·Y^L//Y, y f car *Drosophila melanogaster* stocks (Stock 6 of Table 1). The X·Y^L chromosome came from stocks 7 and 9 of Table 1, and Stock E (Espinet 1976). The Y chromosome came originally from a wild strain (Dempsey 1979). All crosses were made in replicates of three, and initiated with five parental pairs. Stock sources of chromosomes are given in parentheses



X-Y rearrangements have been termed translocations throughout this thesis. This usage is consistent with that of D. L. Lindsley and E. H. Grell's (1968) Genetic Variation of Drosophila melanogaster; however it is worth noting that these rearrangements differ from autosomal translocations in that they occur between chromosomes which are at least partially homologous.

Appendix B

Data Sheets

HYPOTHESIS: 8=10 (effect; y^+)

TIME OF DAY:
I: 10:53 am
II: 12:55 am
III: 12:16 am
IV: 12:45 am

CHAMBER I
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 8
B 10
C
D

IND. GENOTYPE
X Y AUTOSOME
8 $X \cdot Y^L_y$ Y^S sparkling polient
10 $X \cdot Y^L_y$ $Y^S_{y^+}$ sparkling polient

I		II		III		IV	
MATING TYPE	ELAPSED TIME M	MATING TYPE	ELAPSED TIME M	MATING TYPE	ELAPSED TIME M	MATING TYPE	ELAPSED TIME M
1. B	24	1. B	18	1. B	19	1. B	17
2. B	25	2. B	28	2. A	24	2. A	21
3. B	12	3. B	28	3. A	20	3. B	15
4. B	20	4. A	33	4. A	18	4. B	23
5. A	21	5. B	23	5. A	18	5. B	18
6. B	19	6. B	21	6. A	17	6. A	17
7. B	19	7. B	24	7. A	18	7. B	17
8. B	14	8. B	15	8. A	21	8. A	1
9. B	31	9. B	7	9. B	20	9. A	16
10. B	15	10. B	14	10. A	11	10. A	15
11. B	23	11. B	13	11. A	26	11. A	19
12. B	25	12. B	18	12. A	26	12. A	20
13. B	19	13. B	9	13. A	30	13. B	17
14. A	23	14. B	21	14. B	21	14. B	14
15. B	21	15. B	16	15. A	27	15. B	12
16. B	29	16. B	19	16. B	19	16. B	13
17.		17.		17. A	9	17. A	20
18.		18.		18. A	13	18. B	19
19.		19.		19.		19. B	11
20.		20.		20.		20. A	16
21.		21.		21.		21. B	21
22.		22.		22.		22. B	15
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	2	44
B	14	296
C		
D		

	Σ	Σ
A	1	33
B	15	274
C		
D		

	Σ	Σ
A	14	278
B	4	79
C		
D		

	Σ	Σ
A	9	145
B	13	212
C		
D		

HYPOTHESIS: B=10 (effect; y^+)

TIME OF DAY:
I: 3:34 PM
II: 2:37 PM
III: 3:55 PM
IV: 5:00 PM

CHAMBER I — MATING TYPE: FEMALE CHOICE — MATING TYPE: A MALE B x FEMALE

IND GENOTYPE — X Y AUTOSOME

B 10 ____ ____

C ____ ____

D ____ ____

8 $X \cdot Y^l_y$ Y^s spotless sparkling

10 $X \cdot Y^l_y$ $Y^s_{y^+}$ spotless sparkling

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	20	1. B	21	1. B	27	1. B	19
2. B	15	2. B	19	2. A	14	2. B	10
3. B	16	3. B	15	3. A	19	3. A	10
4. A	14	4. B	14	4. A	18	4. B	14
5. A	16	5. B	21	5. A	14	5. B	14
6. B	15	6. B	17	6. A	2	6. B	19
7. B	13	7. B	15	7. A	16	7. A	17
8. B	15	8. B	15	8. B	12	8. B	16
9.		9. B	20	9. A	13	9. B	15
10.		10. B	14	10. B	16	10. B	16
11.		11. B	15	11. A	15	11. A	36
12.		12. B	15	12. A	15	12. B	11
13.		13. B	22	13.		13. A	17
14.		14. A	15	14.		14. B	11
15.		15. B	25	15.		15. B	15
16.		16. B	19	16.		16. B	20
17.		17. B	24	17.		17. B	14
18.		18. B	10	18.		18. B	2
19.		19. B	25	19.		19. B	20
20.		20.		20.		20. A	18
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	2	30	1	15	9	126	5	98
B	6	94	18	326	3	55	15	216
C								
D								

HYPOTHESIS: 8 = 10 (Effect; y+)

TIME OF DAY:
I: 2:20 pm
II: 11:30 am
III: 8:30 PM
IV: 8:30 PM

CHAMBER I
TYPE: FEMALE CHOICE

MATING TYPE: A 8 x FEMALE
B 10
C
D

IND. GENOTYPE
X Y AUTOSOME

8 $X \cdot Y^L y$ Y^S sparkling poliert

10 $X \cdot Y^L y$ Y^{YS}_{y+} sparkling poliert

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	23	1. B	15	1. B	23	1. B	13
2. B	23	2. A	15	2. B	20	2. B	24
3. A	22	3. B	14	3. B	19	3. A	12
4. A	21	4. B	19	4. B	16	4. B	25
5. A	20	5. B	24	5. A	21	5. B	24
6. B	3	6. B	22	6. B	19	6. B	14
7. A	21	7. B	23	7. B	34	7. B	21
8. B	19	8. B	22	8. B	22	8. B	26
9. A	24	9. B	20	9. B	18	9. B	17
10. B	21	10. B	23	10. A	30	10. A	27
11. B	21	11. B	19	11. B	29	11. B	15
12. B	27	12. B	5	12. A	21	12. B	23
13. A	19	13. B	16	13. B	19	13. A	12
14. B	26	14. B	20	14. A	22	14. B	33
15. B	37	15. B	23	15. A	20	15. A	22
16. A	15	16. B	17	16. A	22	16. A	23
17. B	20	17. B	23	17. B	15	17. B	12
18. B	20	18. B	23	18. A	15	18. B	17
19. B	15	19. B	21	19. B	15	19. A	20
20. B	42	20. B	25	20.		20.	
21. A	19	21. A	29	21.		21.	
22. B	24	22. B	20	22.		22.	
23.		23. B	15	23.		23.	
24.		24. B	15	24.		24.	

	Σ	Σ
A	9	184
B	13	273
C		
D		

	Σ	Σ
A	2	44
B	22	424
C		
D		

	Σ	Σ
A	7	151
B	12	249
C		
D		

	Σ	Σ
A	6	116
B	13	264
C		
D		

HYPOTHESIS: 8 = 10 (Effect, y^+)

TIME OF DAY:
I: 2:45 PM
II: 4:56 PM
III: 2:22 PM
IV: 3:49 PM

CHAMBER I — MATING TYPE: FEMALE CHOICE — MATING TYPE: A 8 — MALE x FEMALE

B 10 ____ ____

C ____ ____

D ____ ____

IND. GENOTYPE — X — Y — AUTOSOME

8 $X \cdot Y^L_y$ Y^S sparkling pollen

10 $X \cdot Y^L_y$ Y^S_{y+} sparkling pollen

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	22	1. A	22	1. B	21	1. B	27
2. A	21	2. B	20	2. A	22	2. B	26
3. A	25	3. B	12	3. A	31	3. B	32
4. B	26	4. B	18	4. B	25	4. B	26
5. A	28	5. B	17	5. B	19	5. A	33
6. B	27	6. A	14	6. A	30	6. B	28
7. B	17	7. B	12	7. B	23	7. B	35
8. B	28	8. B	17	8. A	15	8. A	20
9. A	19	9. B	5	9. B	26	9. A	27
10. A	22	10. B	29	10. B	21	10. A	25
11. B	23	11. A	11	11. B	21	11. B	21
12. A	21	12. B	21	12. A	22	12. B	25
13. B	14	13. A	21	13. A	26	13. A	26
14. B	29	14. A	18	14. B	18	14. B	20
15. B	21	15. B	22	15. A	25	15. B	17
16. B	7	16. B	15	16. A	15	16. A	29
17. B	2	17. B	23	17. A	32	17. B	23
18. B	1	18. B	27	18. A	17	18. A	32
19. A	22	19. B	20	19. B	22	19. A	19
20. B	19	20. ___	___	20. A	17	20. A	40
21. A	24	21. ___	___	21. B	17	21. ___	___
22. ___	___	22. ___	___	22. A	15	22. ___	___
23. ___	___	23. ___	___	23. ___	___	23. ___	___
24. ___	___	24. ___	___	24. ___	___	24. ___	___

	Σ	Σ
A	8	182
B	13	236
C	___	___
D	___	___

	Σ	Σ
A	5	86
B	14	258
C	___	___
D	___	___

	Σ	Σ
A	12	267
B	10	213
C	___	___
D	___	___

	Σ	Σ
A	9	251
B	11	280
C	___	___
D	___	___

HYPOTHESIS: 8=10 (Effect; y+)

TIME OF DAY:
I: 11:34 pm
II: 10:11 Am
III: 12:54 PM
IV: 11:06 Am

CHAMBER I
TYPE: FEMALE CHOICE

MATING TYPE: A 8 B 10 C ____ D ____

MALE x FEMALE

IND GENOTYPE
X Y GENOTYPE
8 $X \cdot Y^{L}y$ Y^{S} pdiert sparkling
10 $X \cdot Y^{L}y$ $Y^{S}y+$ pdiert sparkling

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	16	1. B	16	1. B	18	1. B	29
2. B	13	2. B	17	2. A	29	2. B	20
3. B	12	3. B	21	3. A	17	3. A	32
4. A	15	4. B	19	4. B	19	4. A	52
5. B	15	5. B	19	5. B	26	5. A	16
6. B	13	6. B	13	6. B	21	6. B	12
7. B	12	7. B	23	7. B	14	7. B	16
8. A	13	8. B	7	8. B	26	8. B	20
9. B	21	9. A	18	9. A	29	9.	
10. B	12	10. B	24	10. A	8	10.	
11. B	11	11. B	14	11. A	16	11.	
12. B	15	12. B	19	12. B	7	12.	
13. B	12	13. B	15	13.		13.	
14. B	4	14. B	18	14.		14.	
15. B	21	15. B	15	15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	2	28
B	13	177
C		
D		

	Σ	Σ
A	1	18
B	14	240
C		
D		

	Σ	Σ
A	5	99
B	7	131
C		
D		

	Σ	Σ
A	3	100
B	5	97
C		
D		

HYPOTHESIS: 7=9 (Effect y^+)

TIME OF DAY:
I: 2:34 PM
II: 12:00 PM
III: 2:41 PM
IV: 12:35 PM

CHAMBER II
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7 ____
B 9 ____
C ____ ____
D ____ ____

IND. GENOTYPE
X Y AUTOSOME
7 $X \cdot Y^L_y$ Y^S
9 $X \cdot Y^L_y$ Y^S_{y+}

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	15	1. B	14	1. A	11	1. B	20
2. B	16	2. B	17	2. B	21	2. B	25
3. A	16	3. B	9	3. B	16	3. B	15
4. B	20	4. B	16	4. A	16	4. A	16
5. B	14	5. A	26	5. B	14	5. A	19
6. B	21	6. B	25	6. B	14	6. B	20
7. B	29	7. B	22	7. B	16	7. B	20
8. B	13	8. A	9	8. A	13	8. B	17
9. B	19	9. A	12	9. B	15	9. B	13
10. B	15	10. B	20	10. A	10	10. A	15
11. B	18	11. B	16	11. B	15	11. B	21
12. A	20	12. A	17	12. B	21	12. A	16
13. B	13	13. B	21	13. B	14	13. B	29
14. A	19	14. A	31	14. A	19	14. A	21
15. A	21	15. B	19	15. A	20	15. A	15
16. A	16	16. A	16	16. A	12	16. B	16
17. B	23	17. A	22	17. B	21	17. B	17
18. B	18	18. A	12	18. B	14	18. A	31
19. A	21	19. B	16	19. B	14	19. A	16
20. B	54	20. B	21	20. B	12	20. A	17
21. B	18	21. A	6	21. B	13	21. B	19
22. ___	___	22. ___	___	22. B	15	22. B	11
23. ___	___	23. ___	___	23. ___	___	23. B	28
24. ___	___	24. ___	___	24. ___	___	24. B	18

	Σ	Σ
A	6	113
B	15	306
C	___	___
D	___	___

	Σ	Σ
A	9	151
B	12	216
C	___	___
D	___	___

	Σ	Σ
A	7	101
B	15	215
C	___	___
D	___	___

	Σ	Σ
A	9	166
B	15	289
C	___	___
D	___	___

HYPOTHESIS: 7 = 9 (Effect y+)

TIME OF DAY:
I: 1:56 PM
II: 11:20 AM
III: 2:58 PM
IV: 11:00 AM

CHAMBER II
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7 ____
B 9 ____
C ____ ____
D ____ ____

IND. GENOTYPE
X Y AUTOSOME
7 $X \cdot Y^L_y$ Y^S
9 $X \cdot Y^L_y$ Y^S_{y+}

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	8	1. B	21	1. B	15	1. B	16
2. A	12	2. A	16	2. B	20	2. A	11
3. A	1	3. B	20	3. B	24	3. B	20
4. A	15	4. A	24	4. B	15	4. A	28
5. A	19	5. B	17	5. B	14	5. B	17
6. B	21	6. B	17	6. B	22	6. A	16
7. A	15	7. B	23	7. B	34	7. B	9
8. B	14	8. A	20	8. A	22	8. A	15
9. A	19	9. B	21	9. A	16	9. A	19
10. B	25	10. A	17	10. B	20	10. B	20
11. A	18	11. B	23	11. A	14	11. A	20
12. A	10	12. A	23	12. B	18	12. A	12
13. A	22	13. A	19	13. A	17	13. A	4
14. A	16	14. B	19	14. A	20	14. B	14
15. A	18	15. A	19	15. B	16	15. A	19
16. B	18	16. B	19	16. B	4	16. A	5
17. B	13	17. B	20	17. B	15	17. B	16
18. B	17	18. B	12	18. A	19	18. B	16
19. A	20	19. B	18	19. B	15	19. ___	___
20. A	16	20. B	19	20. ___	___	20. ___	___
21. B	16	21. B	18	21. ___	___	21. ___	___
22. A	14	22. A	15	22. ___	___	22. ___	___
23. A	13	23. B	9	23. ___	___	23. ___	___
24. ___	___	24. ___	___	24. ___	___	24. ___	___

	Σ	Σ
A	15	228
B	8	132
C	___	___
D	___	___

	Σ	Σ
A	8	153
B	15	276
C	___	___
D	___	___

	Σ	Σ
A	7	108
B	12	340
C	___	___
D	___	___

	Σ	Σ
A	10	149
B	8	128
C	___	___
D	___	___

HYPOTHESIS: 7 = 9 (Effect y+)

TIME OF DAY:
I: 4:30 PM
II: 1:68 PM
III: 10:28 AM
IV: 1:59 PM

CHAMBER II
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7 ____
B 9 ____
C ____ ____
D ____ ____

IND. GENOTYPE
X Y AUTOSOME

7 $X \cdot Y^L y$ y^S

9 $X \cdot Y^L y$ $y^S y^+$

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	17	1. B	17	1. B	18	1. B	24
2. B	16	2. A	17	2. B	19	2. B	25
3. A	15	3. B	15	3. B	14	3. B	29
4. B	17	4. B	1	4. A	34	4. A	24
5. B	16	5. B	14	5. A	22	5. B	29
6. A	21	6. B	19	6. B	22	6. B	20
7. A	19	7. B	15	7. B	20	7. A	22
8. B	10	8. B	16	8. B	16	8. B	29
9. A	16	9. A	19	9. B	30	9. B	33
10. A	20	10. A	17	10. B	20	10. B	34
11. B	15	11. A	19	11. A	12	11. A	16
12. A	10	12. B	17	12. B	16	12. A	29
13. B	16	13. B	21	13. B	27	13. A	16
14. A	15	14. A	23	14. A	10	14. B	20
15. A	14	15. A	23	15. B	19	15. B	35
16. A	16	16. B	19	16. A	11	16. B	6
17. A	15	17. B	19	17. A	33	17. B	29
18. A	17	18. B	14	18. A	11	18. ___	___
19. A	11	19. B	15	19. A	14	19. ___	___
20. A	5	20. A	17	20. ___	___	20. ___	___
21. B	14	21. A	21	21. ___	___	21. ___	___
22. A	18	22. ___	___	22. ___	___	22. ___	___
23. B	17	23. ___	___	23. ___	___	23. ___	___
24. A	15	24. ___	___	24. ___	___	24. ___	___
25. A	26						
26 B	17						
27 B	14						
	Σ Σ		Σ Σ		Σ Σ		Σ Σ
A	17 270	A	8 156	A	8 147	A	5 107
B	10 152	B	13 202	B	11 221	B	12 322
C	___ ___	C	___ ___	C	___ ___	C	___ ___
D	___ ___	D	___ ___	D	___ ___	D	___ ___

HYPOTHESIS: 7=9 (Effect y+)

TIME OF DAY:
I: 10:40 AM
II: 5:20 PM
III: 4:22 PM
IV: 2:43 PM

CHAMBER II
TYPE: FEMALE CHOICE

MATING MALE x FEMALE
TYPE: A 7 _____
B 9 _____
C _____ _____
D _____ _____

IND GENOTYPE
X Y AUTOSOME
7 $X \cdot Y^{L}_{y}$ Y^{S}
9 $X \cdot Y^{L}_{y}$ Y^{S}_{y+}

I

	MATING TYPE	ELAPSED TIME m
1.	A	15
2.	A	24
3.	B	30
4.	B	28
5.	A	37
6.	B	24
7.	B	37
8.	B	30
9.	B	21
10.	B	33
11.	B	31
12.	A	27
13.	A	25
14.	B	14
15.	B	20
16.	B	20
17.	B	23
18.	A	13
19.	B	30
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	6	141
B	13	341
C		
D		

II

	MATING TYPE	ELAPSED TIME m
1.	B	15
2.	A	26
3.	A	29
4.	B	30
5.	A	25
6.	A	32
7.	B	25
8.	B	30
9.	B	30
10.	A	24
11.	B	27
12.	A	23
13.	B	27
14.	A	27
15.	B	26
16.	A	27
17.	A	32
18.	B	30
19.	B	23
20.	B	18
21.	A	44
22.	A	29
23.	B	5
24.	B	25

	Σ	Σ
A	11	298
B	13	311
C		
D		

III

	MATING TYPE	ELAPSED TIME m
1.	B	21
2.	A	21
3.	A	21
4.	B	20
5.	A	42
6.	B	14
7.	B	26
8.	B	31
9.	B	17
10.	B	30
11.	B	21
12.	A	23
13.	A	27
14.	B	28
15.	B	42
16.	A	13
17.	A	17
18.	A	20
19.	B	16
20.	A	16
21.		
22.		
23.		
24.		

	Σ	Σ
A	9	200
B	11	266
C		
D		

IV

	MATING TYPE	ELAPSED TIME m
1.	B	23
2.	B	12
3.	B	20
4.	B	21
5.	A	28
6.	B	21
7.	A	20
8.	B	20
9.	B	23
10.	B	21
11.	B	20
12.	A	31
13.	A	40
14.	B	33
15.	A	29
16.	B	32
17.	A	14
18.	B	9
19.	B	15
20.	B	10
21.	B	10
22.	A	55
23.	B	55
24.	A	31

	Σ	Σ
A	8	248
B	16	345
C		
D		

HYPOTHESIS: 7 = 9 (Effect y+)

TIME OF DAY:
I: 10:42 AM
II: 2:23 PM
III: 12:10 PM
IV: 4:35 PM

CHAMBER II — TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7
B 9
C
D

IND. GENOTYPE
X Y AUTOSOME

7 $X \cdot Y^L_y$ Y^S

9 $X \cdot Y^L_y$ Y^S_{y+}

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	24	1. B	22	1. A	25	1. B	24
2. B	27	2. B	16	2. A	24	2. B	18
3. B	23	3. B	14	3. B	23	3. B	25
4. A	36	4. B	22	4. B	23	4. B	23
5. A	25	5. A	31	5. B	24	5. A	18
6. B	21	6. B	21	6. A	21	6. A	30
7. B	21	7. B	23	7. A	23	7. A	20
8. B	44	8. B	20	8. A	24	8. B	20
9. B	30	9. B	20	9. A	29	9. A	25
10. B	23	10. B	24	10. A	27	10. B	30
11. A	29	11. B	27	11. A	21	11. B	28
12. A	30	12. A	36	12. A	29	12. A	18
13. A	26	13. B	20	13. B	21	13. A	30
14. A	26	14. B	19	14. A	20	14. B	23
15. B	20	15. B	18	15. A	21	15. B	18
16. B	26	16. B	19	16. B	32	16. B	23
17. A	25	17. B	12	17. B	26	17. B	16
18. A	23	18. A	28	18. B	29	18. A	16
19. A	28	19. A	33	19. A	23	19. A	16
20. A	28	20. B	17	20. A	24	20. A	16
21. A	12	21. A	28	21. B	23	21.	
22. A	8	22. B	16	22. A	26	22.	
23. A	15	23. B	4	23.		23.	
24. A	26	24. B	6	24.		24.	
		25. B	16				
		26. B	20				

	Σ	Σ
A	14	337
B	10	259
C		
D		

	Σ	Σ
A	15	156
B	21	376
C		
D		

	Σ	Σ
A	14	337
B	8	181
C		
D		

	Σ	Σ
A	9	189
B	11	248
C		
D		

HYPOTHESIS: 7 = 9 (Effect y^+)

TIME OF DAY:
I: 4:07 PM
II: 3:43 PM
III: 2:07 PM
IV: 6:16 PM

CHAMBER II
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7 ____
B 9 ____
C ____ ____
D ____ ____

IND. GENOTYPE
X Y AUTOSOM
7 $X \cdot Y^L y$ Y^S
9 $X \cdot Y^L y$ $Y^S_{y^+}$

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	21	1. A	30	1. B	38	1. B	33
2. B	43	2. B	19	2. B	27	2. A	20
3. B	26	3. B	29	3. B	30	3. A	80
4. B	31	4. B	28	4. B	34	4. A	29
5. A	18	5. B	28	5. B	29	5. A	26
6. A	31	6. A	27	6. A	19	6. B	33
7. A	30	7. A	27	7. A	33	7. B	26
8. B	67	8. A	25	8. B	38	8. B	26
9. B	11	9. A	31	9. B	33	9. A	26
10. B	25	10. B	36	10. B	39	10. A	17
11. A	22	11. B	26	11. A	32	11. B	24
12. B	35	12. B	41	12. A	48	12. B	33
13. A	10	13. A	25	13. B	31	13. A	28
14. B	25	14. A	34	14. A	20	14. A	33
15. A	21	15. B	15	15. A	30	15. B	32
16. B	27	16. B	25	16. A	42	16. B	37
17. B	24	17. A	25	17. B	16	17. A	26
18. B	28	18. A	15	18. B	22	18. A	36
19. B	19	19. B	22	19. B	22	19. B	26
20. B	19	20. B	28	20. A	24	20. A	24
21. ___	___	21. B	5	21. B	8	21. B	15
22. ___	___	22. A	20	22. A	25	22. ___	___
23. ___	___	23. ___	___	23. B	30	23. ___	___
24. ___	___	24. ___	___	24. ___	___	24. ___	___

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	7	153	10	259	9	273	11	285
B	13	380	12	302	14	397	10	285
C	___	___	___	___	___	___	___	___
D	___	___	___	___	___	___	___	___

HYPOTHESIS: 7=9 (Effect y+)

TIME OF DAY:
I: 6:12 pm
II: _____
III: _____
IV: _____

CHAMBER II
TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE
A 7 _____
B 9 _____
C _____ _____
D _____ _____

IND. GENOTYPE
X Y AUTOSOME

7 $X \cdot Y^{L}_{y}$ Y^{S}

9 $X \cdot Y^{L}_{y}$ Y^{S}_{y+}

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	20	1.		1.		1.	
2. B	14	2.		2.		2.	
3. B	14	3.		3.		3.	
4. A	29	4.		4.		4.	
5. A	29	5.		5.		5.	
6. A	14	6.		6.		6.	
7. B	14	7.		7.		7.	
8. B	14	8.		8.		8.	
9. B	14	9.		9.		9.	
10. A	14	10.		10.		10.	
11. A	13	11.		11.		11.	
12. B	40	12.		12.		12.	
13. A	13	13.		13.		13.	
14. B	28	14.		14.		14.	
15. A	13	15.		15.		15.	
16. A	13	16.		16.		16.	
17. B	12	17.		17.		17.	
18. A	27	18.		18.		18.	
19. A	48	19.		19.		19.	
20. B	27	20.		20.		20.	
21. B	35	21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	11	233						
B	10	212						
C								
D								

HYPOTHESIS: $\varphi = 2$ (Effect, T(X-Y), sparkling poliert)
A = B = C = D; A + D = C + D

TIME OF DAY:
I: 12:15 PM
II: 3:35 PM
III: 2:27 PM
IV: ____

CHAMBER III
TYPE: MULTIPLE CHOICE

MATING TYPE:	MALE	x	FEMALE
A	9		9
B	9		2
C	2		9
D	2		2

IND. GENOTYPE
X Y AUTOSOME

φ $X \cdot Y^{l}_{y}$ Y^{s}_{y+}

2 X Y spa pol

I

MATING TYPE	ELAPSED TIME m
1. B	38
2. B	15
3. B	18
4. D	21
5. D	22
6. B	17
7. A	16
8. A	19
9. D	18
10. B	12
11. B	13
12. A	27
13. C	7
14. A	15
15. B	17
16. B	16
17. A	19
18. B	15
19. C	21
20. A	12
21. A	13
22. A	11
23. A	1
24.	

	Σ	Σ
A	9	133
B	9	161
C	2	28
D	3	61

II

MATING TYPE	ELAPSED TIME m
1. B	12
2. D	22
3. B	16
4. B	24
5. B	12
6. A	16
7. B	19
8. B	15
9. A	22
10. A	7
11. A	10
12. A	13
13. A	20
14. D	30
15. A	12
16. A	9
17. A	13
18. B	14
19. B	17
20. D	20
21. C	21
22. B	15
23.	
24.	

	Σ	Σ
A	9	102
B	9	144
C	1	21
D	3	72

III

MATING TYPE	ELAPSED TIME m
1. A	17
2. B	17
3. A	20
4. B	17
5. B	15
6. A	22
7. A	11
8. B	22
9. B	23
10. A	6
11. B	15
12. A	9
13. D	11
14. C	5
15. A	5
16. A	1
17. B	12
18. D	23
19. A	14
20. B	15
21. A	10
22. C	22
23. A	14
24. D	27

continued in IV

	Σ	Σ
A		
B		
C		
D		

IV

MATING TYPE	ELAPSED TIME m
1. B	19
2. A	17
3. B	15
4. C	22
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	12	146
B	10	170
C	3	49
D	3	61

HYPOTHESIS: 9=2 (Effect: TC X-V), sparkling poliert
A=B=C=D. A+D=C+B

TIME OF DAY:
I: 3:30 PM
II: 2:52 PM
III: 4:11 PM
IV: 12:52 AM

CHAMBER III

TYPE: MULTIPLE CHOICE

MATING TYPE	MALE	x	FEMALE
A	9		9
B	9		2
C	2		9
D	2		2

IND GENOTYPE
X Y AUTOSOME
9 X·Y^{L} Y$^{S}_{y+}$
2 X Y apa pol

I

MATING TYPE	ELAPSED TIME
1. A	11
2. B	20
3. B	30
4. A	15
5. A	18
6. D	19
7. B	17
8. B	20
9. A	16
10. B	30
11. A	30
12. C	25
13. A	16
14. A	20
15. A	24
16. A	10
17. A	11
18. A	15
19. B	14
20. B	14
21. B	12
22. B	7
23. D	17
24. A	11
25. A	4
26. ~~D~~	~~15~~
27. ~~B~~	~~15~~
	Σ Σ
A	13 201
B	10 179
C	1 25
D	3 51

II

MATING TYPE	ELAPSED TIME
1. D	16
2. A	22
3. B	22
4. A	15
5. B	15
6. B	16
7. B	18
8. B	36
9. A	18
10. B	11
11. C	20
12. A	16
13. B	6
14. D	10
15. A	13
16. A	22
17. A	4
18. B	20
19. A	16
20. A	26
21. B	11
22.	
23.	
24.	
	Σ Σ
A	9 152
B	9 155
C	1 20
D	2 26

III

MATING TYPE	ELAPSED TIME
1. A	13
2. A	17
3. B	26
4. C	18
5. B	33
6. B	25
7. B	10
8. D	19
9. A	6
10. A	18
11. A	11
12. D	10
13. B	7
14. A	10
15. C	11
16. C	10
17. A	26
18. C	25
19. A	8
20. B	9
21. D	10
22. A	15
23. B	15
24.	
	Σ Σ
A	9 124
B	6 125
C	5 64
D	3 39

IV

MATING TYPE	ELAPSED TIME
1. A	15
2. B	12
3. A	15
4. A	14
5. D	18
6. D	28
7. B	15
8. B	24
9. D	13
10. D	16
11. A	11
12. A	14
13. A	16
14. A	9
15. A	21
16. A	11
17. D	26
18. B	13
19. B	9
20. A	16
21. B	12
22. A	12
23. A	14
24.	
	Σ Σ
A	12 168
B	6 85
C	0 0
D	5 101

HYPOTHESIS: 9 = 2 (Effect. T(X-Y), sparkling polient
A = B = C = D; A+D = B+C

TIME OF DAY:
I: 1:20 PM
II:
III:
IV:

CHAMBER III
TYPE: FEMALE CHOICE

MATING TYPE: A 9 x 9
B 9 2
C 2 9
D 2 2

IND GENOTYPE
X Y AUTOSOME
9 $X \cdot Y^L_y$ $Y^{S'}$
2 X Y spa pol.

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	17	1.		1.		1.	
2. A	14	2.		2.		2.	
3. B	15	3.		3.		3.	
4. B	13	4.		4.		4.	
5. C	19	5.		5.		5.	
6. C	18	6.		6.		6.	
7. B	20	7.		7.		7.	
8. A	18	8.		8.		8.	
9. C	10	9.		9.		9.	
10. B	9	10.		10.		10.	
11. A	16	11.		11.		11.	
12. D	19	12.		12.		12.	
13. A	12	13.		13.		13.	
14. B	20	14.		14.		14.	
15. D	19	15.		15.		15.	
16. A	3	16.		16.		16.	
17. B	14	17.		17.		17.	
18. B	24	18.		18.		18.	
19. B	15	19.		19.		19.	
20. D	17	20.		20.		20.	
21. C	18	21.		21.		21.	
22. B	19	22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	6	80						
B	9	149						
C	4	65						
D	3	55						

HYPOTHESIS: 7=2 (Effect $X \cdot y^l, Y^s y$; sparkling pol variant
A=B=C=D; A+D=B+C

CHAMBER IV

TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 4:15 PM
II: 5:20 PM
III: 5:20 PM
IV: 4:06 PM

	MATING TYPE:	MALE	x	FEMALE
	A	7		7
	B	7		2
	C	2		7
	D	2		2

IND. GENOTYPE

	X	Y Autosome
7	$X \cdot y^l y$	Y^s
2	X	Y spa pol

I

MATING TYPE	ELAPSED TIME m
1. A	22
2. A	19
3. A	14
4. A	15
5. C	10
6. A	14
7. D	20
8. D	14
9. A	22
10. A	13
11. C	20
12. D	22
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	7	119
B	0	0
C	2	30
D	3	56

II

MATING TYPE	ELAPSED TIME m
1. D	17
2. A	22
3. D	21
4. B	15
5. A	20
6. D	28
7. A	20
8. A	16
9. D	28
10. A	37
11. A	20
12. A	16
13. A	19
14. A	26
15. D	39
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	9	196
B	1	15
C	0	0
D	5	344

III

MATING TYPE	ELAPSED TIME m
1. A	22
2. A	16
3. A	20
4. C	21
5. C	22
6. A	8
7. D	25
8. A	10
9. A	10
10. A	33
11. A	20
12. D	33
13. A	16
14. D	14
15. B	13
16. A	7
17. D	20
18. B	25
19. A	18
20. D	21
21. B	15
22. D	18
23. A	26
24.	

	Σ	Σ
A	12	206
B	3	53
C	2	43
D	6	131

IV

MATING TYPE	ELAPSED TIME m
1. A	18
2. A	29
3. A	18
4. C	22
5. A	22
6. A	27
7. A	21
8. D	20
9. A	21
10. D	20
11. A	23
12. D	18
13. B	18
14. A	18
15. D	1
16. D	21
17. D	18
18. D	27
19. D	24
20. A	16
21. B	20
22. B	20
23.	
24.	

	Σ	Σ
A	10	213
B	2	58
C	2	22
D	8	149

HYPOTHESIS: 7=2 (Effect: $X \cdot Y^L_y - Y^S_y$ INTERACTION.
X,Y sparkling polist INTERACTION A=B=C=D; A+D=B+C

TIME OF DAY:
I: 4:40 PM
II: 11:43 AM
III: 2:14 PM
IV: 3:33 PM

CHAMBER IV

TYPE: MULTIPLE CHOICE

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	7	7
B	7	2
C	2	7
D	2	2

IND. GENOTYPE

	X	Y	AUTOSOME
7	$X \cdot Y^L_y$	Y^S	
2	X	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	20	1. C	20	1. A	17	1. A	20
2. A	15	2. C	14	2. A	19	2. A	20
3. A	20	3. C	24	3. A	20	3. A	4
4. B	18	4. A	18	4. D	19	4. A	14
5. B	19	5. A	14	5. A	18	5. A	12
6. D	27	6. A	15	6. D	20	6. A	15
7. D	17	7. D	21	7. A	16	7. D	24
8. A	20	8. A	14	8. D	8	8. A	14
9. D	33	9. C	20	9. C	20	9. C	18
10. D	22	10. C	22	10. C	17	10. A	13
11. C	29	11. D	21	11. A	13	11. D	15
12. C	31	12. A	19	12. A	20	12. D	21
13. A	30	13. D	21	13. D	13	13. A	21
14. A	16	14. D	25	14.		14. D	20
15. A	17	15. A	19	15.		15. D	15
16. D	30	16. B	14	16.		16. B	10
17. D	25	17. B	18	17.		17. D	11
18. D	15	18. D	16	18.		18. B	14
19. B	20	19. D	15	19.		19. D	31
20. D	38	20. A	13	20.		20. B	14
21. A	16	21.		21.		21. D	19
22. C	19	22.		22.		22. D	4
23. A	15	23.		23.		23. A	19
24.		24.		24.		24. A	16
						25. C	15

	Σ	Σ
A	9	169
B	3	57
C	3	69
D	8	207

	Σ	Σ
A	7	112
B	2	32
C	5	100
D	6	119

	Σ	Σ
A	7	124
B	0	0
C	2	37
D	4	60

	Σ	Σ
A	11	168
B	3	38
C	2	33
D	9	160

HYPOTHESIS: 7=2 (Effect $X \cdot Y^L y^- {}^S y$ INTERACTION X, Y, sparkling polish INTERACTION) A=B=C=D; A+D=B+C

CHAMBER IV ♂ MATING MALE x FEMALE

TYPE: MULTIPLE CHOICE TYPE: A 7 7

B 7 2

C 2 7

D 2 2

TIME OF DAY:
I: 11:50 AM
II: 12:53 PM
III: 1:53 PM
IV: 5:28 PM

STOCK	GENOTYPE X	Y	AUTOSOME
7	$X \cdot Y^L y$		y^S
2	X	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME M	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. D	28	1. D	22	1. A	22	1. D	16
2. A	20	2. B	14	2. A	18	2. A	17
3. D	23	3. A	22	3. A	22	3. A	20
4. D	29	4. A	21	4. A	21	4. A	18
5. D	25	5. A	15	5. A	20	5. D	23
6. C	21	6. A	24	6. D	20	6. D	20
7. A	23	7. D	30	7. D	21	7. A	15
8. C	24	8. D	26	8. A	19	8. B	15
9. A	21	9. A	21	9. A	17	9. A	22
10. D	30	10. D	12	10. D	22	10. A	14
11. A	9	11. D	30	11. D	20	11. C	19
12. D	17	12. A	25	12. A	17	12. A	7
13. D	28	13. A	11	13. D	26	13. D	19
14. A	13	14. A	22	14. A	17	14. A	18
15. C	22	15. C	15	15. A	20	15. D	16
16. D	14	16. D	17	16. D	14	16. D	15
17. C	20	17. A	14	17. D	27	17. C	21
18. C	23	18. B	22	18. D	21	18.	
19. B	20	19. B	18	19. A	15	19.	
20.		20. D	34	20. C	24	20.	
21.		21. D	20	21. B	18	21.	
22.		22. A	13	22. B	13	22.	
23.		23. A	17	23. D	28	23.	
24.		24. B	25	24. A	18	24.	

	Σ	Σ
A	5	86
B	1	20
C	5	110
D	8	194

	Σ	Σ
A	11	205
B	4	79
C	1	15
D	8	191

	Σ	Σ
A	12	226
B	2	31
C	1	21
D	9	199

	Σ	Σ
A	8	131
B	1	15
C	2	40
D	6	109

HYPOTHESIS: 7=2; (Effect: $X \cdot Y^L - Y^S$ y INTERACTION; X-y, sparkling pol INTERACTION) A=B=C=D; A+D=B+C

TIME OF DAY: I: 3:13 PM II: ____ III: ____ IV: ____

CHAMBER IV

TYPE: MULTIPLE CHOICE

MATING TYPE: MALE x FEMALE

A 7 7

B 7 2

C 2 7

D 2 2

STOCK GENOTYPE: X Y AUTOSOME

7 $X \cdot Y^L_y$ Y^S

2 X Y spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	23	1.		1.		1.	
2. A	18	2.		2.		2.	
3. A	22	3.		3.		3.	
4. D	20	4.		4.		4.	
5. A	26	5.		5.		5.	
6. C	15	6.		6.		6.	
7. D	16	7.		7.		7.	
8. A	20	8.		8.		8.	
9. C	17	9.		9.		9.	
10. D	13	10.		10.		10.	
11. C	14	11.		11.		11.	
12. D	20	12.		12.		12.	
13. D	14	13.		13.		13.	
14. C	6	14.		14.		14.	
15. D	5	15.		15.		15.	
16. C	19	16.		16.		16.	
17. A	20	17.		17.		17.	
18. D	28	18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	6	129
B	0	0
C	5	71
D	7	116

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 10 = 2; (Effect: T(X-Y)
A=B=C=D; A+D=B+C

CHAMBER V
TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 4:05 PM
II: 4:35 PM
III: 1:56 PM
IV: 2:40 PM

MATING TYPE:	MALE	x	FEMALE
A	10		10
B	10		2
C	2		10
D	2		2

STOCK	GENOTYPE X	GENOTYPE Y	AUTOSOME
10	$X \cdot Y^{l}_{y}$	Y^{s}_{y+}	spa pol
2	X	Y	spa pol

I

MATING TYPE	ELAPSED TIME m
1. A	13
2. D	20
3. C	20
4. A	7
5. A	14
6. A	10
7. C	16
8. C	19
9. D	23
10. C	26
11. D	22
12. C	25
13. A	9
14. D	20
15. A	12
16. D	17
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	6	65
B	0	0
C	5	106
D	5	102

II

MATING TYPE	ELAPSED TIME m
1. C	19
2. D	12
3. D	25
4. C	18
5. D	25
6. C	23
7. D	18
8. D	19
9. D	16
10. C	17
11. D	16
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	0	0
B	0	0
C	4	77
D	7	131

III

MATING TYPE	ELAPSED TIME m
1. B	32
2. D	20
3. A	16
4. D	15
5. B	14
6. C	31
7. B	18
8. B	15
9. C	21
10. A	20
11. C	21
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	2	36
B	4	79
C	3	73
D	2	35

IV

MATING TYPE	ELAPSED TIME m
1. C	29
2. C	24
3. A	15
4. A	15
5. C	22
6. D	16
7. A	2
8. B	13
9. B	9
10. A	20
11. D	15
12. C	23
13. B	13
14. B	14
15. A	16
16. D	27
17. A	15
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	6	83
B	4	49
C	4	98
D	3	58

HYPOTHESIS: 10=2; (Effect: T(x-y))

A=B=C=D; A+D=B+C

CHAMBER V

TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 11:24 AM
II: 1:34 PM
III: 10:36 AM
IV: 10:52 AM

	MATING TYPE:	MALE	x	FEMALE
	A	10		10
	B	10		2
	C	2		10
	D	2		2

STOCK	GENOTYPE X	Y	AUTOSOME
10	$X \cdot Y^{l}_{y}$	Y^{s}_{y+}	spa pol
2	X	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	22	1. D	25	1. D	9	1. C	30
2. A	26	2. D	28	2. A	14	2. A	19
3. A	16	3. D	32	3. A	27	3. D	30
4. C	24	4. C	23	4. A	14	4. D	30
5. D	31	5. A	18	5. C	27	5. A	15
6. D	25	6. B	19	6. D	12	6. C	26
7. D	26	7. C	25	7. B	20	7. B	20
8. D	20	8. D	17	8. C	17	8. D	29
9. A	12	9. A	42	9. C	19	9. D	35
10. A	11	10. D	26	10. D	20	10. C	33
11. A	19	11. C	30	11. D	21	11. A	6
12. D	10	12. C	5	12. D	25	12. C	20
13. D	26	13. C	28	13. D	22	13. D	20
14. D	29	14. B	12	14. D	25	14. C	26
15. C	21	15. A	21	15. A	21	15. C	23
16. D	22	16. D	11	16. D	19	16. D	30
17. D	22	17. B	18	17. A	19	17. B	17
18. D	24	18. A	21	18. A	39	18. D	32
19.		19. B	15	19. C	9	19. C	15
20.		20. D	38	20. C	21	20. A	14
21.		21. B	20	21. A	7	21. C	14
22.		22. C	19	22. D	29	22.	
23.		23. C	28	23. B	16	23.	
24.		24. B	23	24. D	22	24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	6	106	4	102	7	141	4	54
B	0	0	6	107	2	36	2	37
C	2	45	7	158	5	93	8	187
D	10	235	7	177	10	204	7	206

HYPOTHESIS: 10=2; (Effect: T(X-Y))
A=B=C=D; A+D=B+C

TIME OF DAY:
I: 10:46
II:
III:
IV:

CHAMBER V
TYPE: MULTIPLE CHOICE

MATING TYPE: A 10 x 10
B 10 2
C 2 10
D 2 2

STOCK	GENOTYPE X	Y	AUTOSOME
10	$X \cdot Y^{L}_{y}$	Y^{S}_{y+}	spa pol
2	X	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME M	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. D	22	1.		1.		1.	
2. A	24	2.		2.		2.	
3. C	30	3.		3.		3.	
4. C	20	4.		4.		4.	
5. A	17	5.		5.		5.	
6. D	25	6.		6.		6.	
7. C	37	7.		7.		7.	
8. A	24	8.		8.		8.	
9. D	29	9.		9.		9.	
10. D	54	10.		10.		10.	
11. B	20	11.		11.		11.	
12. A	31	12.		12.		12.	
13. C	17	13.		13.		13.	
14. C	25	14.		14.		14.	
15. D	19	15.		15.		15.	
16. A	15	16.		16.		16.	
17. C	11	17.		17.		17.	
18. C	24	18.		18.		18.	
19. A	19	19.		19.		19.	
20. B	23	20.		20.		20.	
21. D	2	21.		21.		21.	
22. D	26	22.		22.		22.	
23. D	28	23.		23.		23.	
24. D	15	24.		24.		24.	

	Σ	Σ
A	6	130
B	2	43
C	7	164
D	9	220

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 8=2. (Effect: T(x-y),y INTERACTION
X-Y sparkling potient INTERACTION; A=B=C=D; A+D=B+C

CHAMBER VI

TYPE: MULTIPLE CHOICE

STOCK	GENOTYPE X	Y	AUTOSOME
8	$X \cdot Y^{L}_{y}$	Y^{S}	spa pol
2	X	Y	spa pol

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	8	8
B	8	2
C	2	8
D	2	2

TIME OF DAY:
I: 6:38 PM
II: 3:18 PM
III: 5:20 PM
IV: 2:49 PM

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	28	1. D	1	1. C	24	1. D	24
2. C	14	2. D	33	2. B	14	2. C	25
3. C	19	3. C	19	3. C	17	3. D	20
4. C	14	4. D	24	4. C	15	4. A	22
5. A	14	5. C	36	5. C	17	5. C	24
6. A	14	6. D	17	6. D	20	6. D	25
7. C	16	7. D	26	7. D	27	7. C	25
8. D	21	8. A	12	8. D	30	8. C	25
9. A	15	9. D	19	9. C	20	9. C	25
10. C	23	10. C	27	10.		10. C	26
11. C	16	11. D	19	11.		11. C	21
12. C	22	12. A	30	12.		12. C	24
13. D	19	13. D	23	13.		13. D	21
14. D	26	14. A	16	14.		14. D	27
15.		15. A	1	15.		15. D	26
16.		16. A	13	16.		16. C	23
17.		17.		17.		17. D	20
18.		18.		18.		18. D	22
19.		19.		19.		19. D	20
20.		20.		20.		20. A	16
21.		21.		21.		21. C	15
22.		22.		22.		22. D	22
23.		23.		23.		23.	
24.		24.		24.		24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	3	43	5	72	0	0	2	38
B	0	0	0	0	1	14	0	0
C	8	152	8	82	5	93	10	233
D	3	66	8	162	3	77	10	227

HYPOTHESIS: B=2; (Effect T(x-y)y, INTERACTION; X-Y sparkling pollen INTERACTION; A=B=C=D; A+D=B+C

TIME OF DAY:
I: 1:45 PM
II: 2:00 PM
III: 12:51 PM
IV: 10:26 AM

CHAMBER VI

TYPE: MULTIPLE CHOICE

MATING TYPE: A 8 8; B 8 2; C 2 8; D 2 2

STOCK	GENOTYPE X	Y	AUTOSOME
8	$X \cdot Y^{l}_{y}$	Y^{6}	spa pol
2	X	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	10	1. A	1	1. D	34	1. D	28
2. C	18	2. A	16	2. D	46	2. D	32
3. D	31	3. D	24	3. C	1	3. C	53
4. C	15	4. C	18	4. C	25	4. C	17
5. D	19	5. C	33	5. C	39	5. C	24
6. C	17	6. B	5	6. C	11	6. D	29
7. C	18	7. C	29	7. D	30	7. D	21
8. D	16	8. D	21	8. C	17	8. A	19
9. D	27	9.		9. C	25	9. C	31
10. C	16	10.		10. A	17	10. C	20
11. D	19	11.		11. C	15	11. D	10
12. D	22	12.		12. C	29	12. D	10
13. C	23	13.		13. D	23	13.	
14. C	21	14.		14. C	40	14.	
15. C	20	15.		15. D	22	15.	
16. C	20	16.		16. D	14	16.	
17. D	21	17.		17. C	20	17.	
18. C	20	18.		18. C	1	18.	
19. D	24	19.		19. C	19	19.	
20. D	27	20.		20. D	20	20.	
21. C	20	21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	0		2	17	1	17	1	19
B	0		1	5	0	0	0	0
C	12	218	3	80	12	242	5	145
D	9	206	2	45	7	189	6	130

HYPOTHESIS: B=2; (Effect T(X-Y) y & INTERACTION
X-Y sparkling poliert INTERACTION A=B=C=D; A+D = B+C

TIME OF DAY:
I: 8:54 PM
II: 10:32 AM
III: 3:26 PM
IV: 4:00 PM

CHAMBER VI
TYPE: MULTIPLE CHOICE

MATING TYPE: MALE A B x FEMALE B 8

STOCK	GENOTYPE X	Y	AUTOSOME
8	X·Y^{l}y	Y^{s}	spa^{pol}
2.	X	Y	spa$^{pol.}$

	MALE	FEMALE
B	8	2
C	2	8
D	2	2

I

MATING TYPE	ELAPSED TIME m
1. A	20
2. A	19
3. C	20
4. D	20
5. C	27
6. D	31
7. A	21
8. C	15
9. A	13
10. A	22
11. C	36
12. D	23
13. D	15
14. D	15
15. B	20
16. D	19
17. B	22
18. C	7
19. A	24
20. D	15
21. C	21
22. D	21
23. C	24
24. D	18
25. D	17
26. D	18

	Σ	Σ
A	6	119
B	2	42
C	7	150
D	11	212

II

MATING TYPE	ELAPSED TIME m
1. C	25
2. A	24
3. A	27
4. C	32
5. D	47
6. D	38
7. A	25
8. D	21
9. C	23
10. C	38
11. C	37
12. A	29
13. B	28
14. D	43
15. D	42
16. B	37
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	4	105
B	2	65
C	5	155
D	5	191

III

MATING TYPE	ELAPSED TIME m
1. D	23
2. D	31
3. C	29
4. A	25
5. C	37
6. C	32
7. D	31
8. A	23
9. D	34
10. A	34
11. D	28
12. C	37
13. D	51
14. D	35
15. C	26
16. A	26
17. A	14
18. D	25
19. D	21
20. A	20
21. D	22
22. D	32
23. C	25
24.	

	Σ	Σ
A	6	142
B	0	0
C	6	186
D	11	333

IV

MATING TYPE	ELAPSED TIME m
1. D	21
2. D	14
3. C	24
4. C	28
5. D	33
6. D	23
7. D	42
8. C	32
9. A	11
10. A	30
11. D	5
12. D	9
13. C	24
14. A	11
15. C	10
16. C	24
17. D	20
18. D	26
19. D	27
20. D	15
21. D	15
22.	
23.	
24.	

	Σ	Σ
A	3	52
B	0	0
C	6	142
D	12	250

HYPOTHESIS: 4=3; (Effect y AND sparkling polint) TIME OF DAY:
A=B=C=D, A+D=B+C

I: 5:20 PM
II: 5:54 PM
III: 5:00 PM
IV: 4:27 PM

CHAMBER XII MATING MALE x FEMALE
TYPE: MULTIPLE CHOICE TYPE: A 3 3
B 3 4
C
D

STOCK	GENOTYPE X	Y	AUTOSOME
3	X_y	Y	spa pol
4	$X^{\bullet}{}_{y^+}$	Y	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	21	1. C	28	1. D	40	1. C	28
2. A	25	2. C	49	2. C	32	2. D	30
3. C	19	3. C	20	3. B	41	3. C	35
4. C	19	4. A	45	4. C	45	4. C	24
5. C	25	5. C	22	5. C	40	5. D	22
6. C	18	6. D	30	6. A	40	6. D	22
7. C	20	7. D	22	7. C	32	7. A	31
8. D	24	8. C	20	8. A	30	8. C	24
9. C	19	9. C	20	9. D	25	9. A	17
10. C	17	10. B	12	10. B	32	10. D	20
11. D	24	11. D	19	11. C	25	11. D	17
12. C	22	12. A	10	12. D	25	12. D	27
13. A	15	13. C	10	13. A	20	13. A	27
14. A	26	14. D	20	14. C	18	14. D	28
15. D	18	15. C	27	15. D	21	15. D	17
16.		16. D	27	16. D	15	16. C	24
17.		17. D	19	17.		17. A	28
18.		18. C	27	18.		18. D	20
19.		19. D	26	19.		19. A	20
20.		20. D	26	20.		20. A	29
21.		21. C	21	21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	3	66	2	55	3	90	6	152
B	0	0	1	12	2	73	0	0
C	9	180	10	244	6	192	5	135
D	3	66	8	189	5	126	9	203

HYPOTHESIS: 9=10 (Effect sparkling polest)
A=B, C=D; A=B=C=D; A+D=B+C

CHAMBER VIII

TYPE: MALE CHOICE AND MULTIPLE CHOICE

TIME OF DAY:
I: 5:30 PM
II: 2:45 PM
III: 3:34 PM
IV: 4:00 PM

MATING TYPE	MALE	x	FEMALE
A	9		9
B	9		10
C	10		9
D	10		10

STOCK	GENOTYPE X	Y AUTOSOME
9	$X \cdot Y^{L}_{y}$	Y^{S}_{y+}
10	$X \cdot Y^{L}_{y}$	Y^{S}_{y+} spa pol

I MATING TYPE	I ELAPSED TIME m	II MATING TYPE	II ELAPSED TIME m	III MATING TYPE	III ELAPSED TIME m	IV MATING TYPE	IV ELAPSED TIME m
1. B	16	1. D	14	1. D	24	1. B	33
2. B	23	2. C	15	2. B	28	2. B	30
3. B	14	3. D	15	3. B	15	3. B	33
4. A	13	4. C	16	4. B	21	4. D	23
5. B	16	5. D	9	5. B	18	5. A	22
6. B	31	6. C	16	6. B	20	6. B	25
7. B	13	7. D	15	7. A	30	7. C	10
8. B	13	8. D	24	8. A	23	8. B	10
9. A	17	9. C	14	9. A	18	9. A	10
10. B	17	10. D	12	10. A	32	10. A	10
11. B	12	11. C	16	11. D	11	11. D	29
12. A	17	12. C	14	12. C	15	12. C	18
13. A	20	13. C	8	13. B	17	13. A	15
14. A	11	14. D	16	14. B	52	14. B	13
15. A	12	15. D	15	15. D	12	15. D	7
16. B	13	16. C	13	16. A	21	16. A	26
17. A	31	17. C	12	17. B	37	17. B	25
18.		18.		18. C	13	18. A	17
19.		19.		19. B	13	19.	
20.		20.		20. A	11	20.	
21.		21.		21. A	11	21.	
22.		22.		22. A	18	22.	
23.		23.		23. B	17	23.	
24.		24.		24. A	17	24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	7	121			9	181	6	100
B	10	168			10	238	7	169
C			9	124	2	98	2	98
D			8	120	3	47	3	59

HYPOTHESIS: 4=3 (Effect y AND sparkling polish)
A=B=C=D ; A+D = B+C

TIME OF DAY:
I: 10:29 AM
II:
III:
IV:

CHAMBER VII

TYPE: MULTIMALE CHOICE

MATING TYPE	MALE	x	FEMALE
A	3		3
B	3		4
C	4		3
D	4		4

STOCK	GENOTYPE X	Y	AUTOSOME
3	X^y	Y	spapol
4	$X^{\cdot}y^+$	Y	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. D	15	1.		1.		1.	
2. C	13	2.		2.		2.	
3. C	11	3.		3.		3.	
4. D	4	4.		4.		4.	
5. D	10	5.		5.		5.	
6. D	12	6.		6.		6.	
7. C	25	7.		7.		7.	
8. D	10	8.		8.		8.	
9. C	15	9.		9.		9.	
10. C	14	10.		10.		10.	
11. C	7	11.		11.		11.	
12. C	38	12.		12.		12.	
13. A	26	13.		13.		13.	
14. A	13	14.		14.		14.	
15. D	31	15.		15.		15.	
16. C	17	16.		16.		16.	
17. A	16	17.		17.		17.	
18. C	31	18.		18.		18.	
19. A	14	19.		19.		19.	
20. C	19	20.		20.		20.	
21. C	9	21.		21.		21.	
22. C	16	22.		22.		22.	
23. D	14	23.		23.		23.	
24. D	15	24.		24.		24.	

	Σ	Σ
A	4	69
B	0	0
C	11	815
D	8	111

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: $9=10$ (Effect sparkling poliert
$A=B, C=D$; $A=B=C=D$; $A+D=B+C$

CHAMBER VIII

TYPE: MULTIPLE CHOICE AND MALE CHOICE

TIME OF DAY:
I: 5:42 PM
II: 5:37 PM
III: 5:40 PM
IV: 4:41 PM

MATING TYPE	MALE	×	FEMALE
A	9		9
B	9		10
C	10		9
D	10		10

STOCK GENOTYPE

	X	Y	AUTOSOME
9	$X \cdot y^L y$	$y^S_{y^+}$	
10	$X \cdot y^L y$	$y^{S'}_{y^+}$	opa pol

I

	MATING TYPE	ELAPSED TIME m
1.	B	21
2.	C	22
3.	B	21
4.	B	19
5.	A	12
6.	B	6
7.	A	15
8.	B	15
9.	B	15
10.	C	46
11.	A	9
12.	C	42
13.	C	42
14.	D	36
15.	D	36
16.	A	36
17.	B	35
18.	A	37
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	5	109
B	7	132
C	4	152
D	2	72

II

	MATING TYPE	ELAPSED TIME m
1.	A	16
2.	A	16
3.	A	20
4.	B	19
5.	B	17
6.	A	15
7.	D	27
8.	D	12
9.	B	25
10.	A	22
11.	A	20
12.	B	30
13.	D	20
14.	B	25
15.	B	37
16.	B	27
17.	B	18
18.	D	13
19.	C	23
20.	A	23
21.	A	4
22.	C	15
23.		
24.		

	Σ	Σ
A	8	136
B	8	198
C	2	38
D	4	72

III

	MATING TYPE	ELAPSED TIME m
1.	D	21
2.	D	31
3.	D	8
4.	C	24
5.	D	28
6.	C	34
7.	D	10
8.	C	28
9.	D	12
10.	C	35
11.	D	13
12.	C	29
13.	C	16
14.	C	28
15.	D	8
16.	D	21
17.	C	13
18.	C	15
19.	D	20
20.	C	15
21.		
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	10	237
D	10	172

IV

	MATING TYPE	ELAPSED TIME m
1.	C	25
2.	D	41
3.	C	19
4.	C	25
5.	D	18
6.	D	15
7.	D	22
8.	D	15
9.	C	22
10.	D	30
11.	D	20
12.	C	22
13.	D	17
14.	C	17
15.	D	32
16.	D	15
17.	C	15
18.	D	15
19.	C	15
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	8	160
D	11	240

HYPOTHESIS: 9=10 (effect sparkling polish) C=D

TIME OF DAY:
I: 10:50 AM
II: 4:15 PM
III:
IV:

CHAMBER VIII

TYPE: MALE CHOICE

MATING TYPE: MALE x FEMALE

A
B
C 10 9
D 10 10

STOCK	GENOTYPE X	GENOTYPE Y	AUTOSOME
9	$X \cdot Y^L_y$	Y^6_{y+}	
10	$X \cdot Y^L_y$	Y^6	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	26	1. C	23	1.		1.	
2. D	25	2. D	23	2.		2.	
3. D	21	3. D	22	3.		3.	
4. C	23	4. C	22	4.		4.	
5. C	30	5. D	22	5.		5.	
6. C	23	6. C	25	6.		6.	
7. C	21	7. D	16	7.		7.	
8. D	26	8. D	36	8.		8.	
9. C	16	9. C	10	9.		9.	
10. C	20	10. D	12	10.		10.	
11. C	19	11. D	14	11.		11.	
12. D	19	12. C	14	12.		12.	
13. C	20	13. C	10	13.		13.	
14. C	14	14. D	25	14.		14.	
15. D	14	15. C	23	15.		15.	
16. D	29	16. D	13	16.		16.	
17. D	12	17. D	31	17.		17.	
18. D	7	18. D	7	18.		18.	
19. C	42	19. D	18	19.		19.	
20. D	19	20. C	4	20.		20.	
21. D	8	21. C	19	21.		21.	
22. D	15	22. C	24	22.		22.	
23.		23. C	10	23.		23.	
24.		24.		24.		24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A								
B								
C	11	254	11	184				
D	11	195	12	239				

HYPOTHESIS: 7=8 (effect sparkling polert
A=B=C=D; A+D=C+B.

TIME OF DAY:
I: 3:07 PM
II: 1:44 PM
III: 3:20 PM
IV:

CHAMBER IX
TYPE: MULTIPLE CHOICE

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	7	7
B	7	8
C	8	7
D	8	8

STOCK	GENOTYPE X	Y	AUTOSOME
7	$X \cdot Y^l_y$	Y^s	
8	$X \cdot Y^l_y$	Y^s	spa pol

I

MATING TYPE	ELAPSED TIME m
1. A	19
2. B	18
3. A	17
4. A	22
5. A	15
6. A	12
7. A	14
8. A	17
9. C	47
10. B	14
11. A	19
12. A	12
13. A	19
14. B	10
15. B	9
16. B	16
17. D	21
18. C	14
19. D	25
20. D	19
21. C	19
22. B	15
23.	
24.	

	Σ	Σ
A	10	166
B	6	82
C	3	80
D	3	65

II

MATING TYPE	ELAPSED TIME m
1. B	20
2. B	16
3. B	14
4. A	20
5. B	17
6. B	14
7. C	17
8. B	15
9. C	82
10. D	16
11. A	15
12. D	15
13. D	11
14. B	10
15. A	22
16. B	13
17. A	4
18. B	17
19. A	16
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	5	77
B	9	136
C	2	39
D	3	42

III

MATING TYPE	ELAPSED TIME m
1. B	20
2. A	19
3. A	18
4. B	17
5. B	15
6. A	13
7. B	21
8. A	6
9. A	13
10. A	37
11. B	20
12. A	10
13. A	13
14. D	19
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	8	129
B	6	112
C		
D		

IV

MATING TYPE	ELAPSED TIME m
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 2=3 (Effect y)
A=B=C=D; A+D=C+B

CHAMBER X
TYPE: MULTIPLE CHOICE

MATING TYPE: A 3 x 3
B 3 x 2
C 2 x 3
D 2 x 2

TIME OF DAY:
I: 10:16 PM
II: 1:45 PM
III: 1:10 PM
IV: 10:17 PM

STOCK	GENOTYPE X	Y	AUTOSOME
2	X_{y^+}	Y	sparkling (not pliert)
3	X_y	Y	sparkling (pliert)

I

MATING TYPE	ELAPSED TIME m
1. C	23
2. D	14
3. D	19
4. A	14
5. C	34
6. C	24
7. D	24
8. A	25
9. C	12
10. C	16
11. C	29
12. D	39
13. A	33
14. C	23
15. D	16
16. A	80
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	4	92
B	0	0
C	7	161
D	5	112

II

MATING TYPE	ELAPSED TIME m
1. C	30
2. C	11
3. D	28
4. A	23
5. D	9
6. A	22
7. D	21
8. A	24
9. A	18
10. C	16
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	4	87
B	0	0
C	3	57
D	3	58

III

MATING TYPE	ELAPSED TIME m
1. B	20
2. A	9
3. D	28
4. A	17
5. A	30
6. A	26
7. C	19
8. A	26
9. B	20
10. A	24
11. C	24
12. D	25
13. D	26
14. D	20
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	6	132
B	2	40
C	2	43
D	4	99

IV

MATING TYPE	ELAPSED TIME m
1. D	30
2. C	27
3. D	25
4. D	41
5. A	24
6. D	44
7. D	35
8. C	35
9. C	36
10. D	25
11. D	20
12. A	28
13. A	26
14. C	16
15. D	17
16. C	29
17. D	19
18. A	13
19. A	19
20. D	17
21. D	24
22. A	37
23. D	12
24. C	24
25. B	26

	Σ	Σ
A	6	147
B	1	26
C	6	167
D	12	309

HYPOTHESIS: 2=3, (Effect y)
A=B=C=D; A+D=C+B

CHAMBER X
TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 5:47 PM
II: 11:11 AM
III: 12:01 PM
IV: 5:15 PM

MATING TYPE: A 3 x 3; B 3 x 2; C 2 x 3; D 2 x 2

STOCK	GENOTYPE X	Y	AUTOSOME
2	X_{y+}	Y	spa pol
3	X_{y}	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	30	1. D	28	1. D	30	1. C	27
2. D	23	2. D	18	2. D	36	2. C	40
3. D	28	3. C	39	3. C	27	3. D	24
4. C	23	4. A	25	4. C	35	4. A	22
5. D	23	5. C	28	5. A	29	5. C	26
6. C	23	6. C	28	6. D	26	6. D	28
7. B	38	7. C	30	7. A	27	7. B	21
8. D	26	8. A	28	8. D	29	8. D	27
9. D	23	9. C	36	9. C	25	9. D	28
10. A	25	10. B	26	10. C	28	10. A	32
11. D	20	11. D	18	11. A	30	11. C	15
12. D	33	12. A	27	12. C	30	12. D	20
13. A	25	13. C	26	13. D	30	13. D	28
14. A	27	14. D	24	14. A	30	14. A	19
15. A	26	15. D	26	15. A	28	15. A	21
16. D	19	16. A	11	16. C	28	16. A	24
17. A	21	17. D	8	17. A	19	17. D	31
18. A	21	18. C	24	18. D	25	18. D	31
19. C	20	19. D	27	19. D	4	19. C	15
20. D	11	20. D	25	20. D	19	20. D	15
21. C	22	21. D	31	21. D	23	21.	
22. D	26	22. A	32	22. D	36	22.	
23. C	23	23. B	23	23. D	23	23.	
24. D	26	24. D	16	24. D	30	24.	
				25. D	21		

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	6	145	5	123	6	163	5	118
B	1	38	2	49	0	0	1	21
C	6	141	7	211	6	173	5	123
D	11	258	10	221	13	332	9	232

HYPOTHESIS: 3=2 (Effect y)
A=B=C=D; A+D=B+C

TIME OF DAY:
I: 2:22
II:
III:
IV:

CHAMBER X
TYPE: MULTIPLE CHOICE

MATING TYPE: MALE x FEMALE

A 3 3
B 3 2
C 2 3
D 2 2

STOCK GENOTYPE

	X	Y	AUTOSOME
2	X^{y+}	Y	spa pol
3	X^{y}	Y	spa pol

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	31	1.		1.		1.	
2. C	28	2.		2.		2.	
3. C	36	3.		3.		3.	
4. D	25	4.		4.		4.	
5. D	23	5.		5.		5.	
6. C	35	6.		6.		6.	
7. C	17	7.		7.		7.	
8. A	37	8.		8.		8.	
9. C	31	9.		9.		9.	
10. D	32	10.		10.		10.	
11. A	25	11.		11.		11.	
12. A	25	12.		12.		12.	
13. B	24	13.		13.		13.	
14. C	26	14.		14.		14.	
15. C	26	15.		15.		15.	
16. D	7	16.		16.		16.	
17. C	35	17.		17.		17.	
18. D	23	18.		18.		18.	
19. C	30	19.		19.		19.	
20. D	45	20.		20.		20.	
21. D	35	21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	3	87
B	1	24
C	10	295
D	7	190

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 1 = 7 (Effect; $X \cdot Y^L$, Y^S, & y)

A = B = C = D; A + D = C + B

CHAMBER ~~XI~~ MATING MALE x FEMALE

TYPE: MULTIPLE CHOICE TYPE: A 7 7

TIME OF DAY:
I: 1:29 PM
II: 10:20 AM
III: 4:29 PM
IV: 9:30 AM

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y^+}	Y	
7	$X \cdot Y^L_y$	Y^S	

B	7	1
C	1	7
D	1	1

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	13	1. C	9	1. D	27	1. D	38
2. C	17	2. C	19	2. D	26	2. D	26
3. C	15	3. A	18	3. C	27	3. D	23
4. C	15	4. C	32	4. D	28	4. D	21
5. C	20	5. A	2	5. C	18	5. C	26
6. A	5	6. A	2	6. D	30	6. C	26
7. C	22	7. B	10	7. C	21	7. C	43
8. A	11	8. C	47	8. C	27	8. D	22
9. D	15	9. D	10	9. A	22	9. D	25
10. C	21	10. A	10	10. D	25	10. A	30
11. C	16	11. A	2	11. C	30	11. A	27
12. D	13	12. D	12	12. D	30	12. D	25
13. C	16	13. D	8	13. A	35	13. C	20
14. C	15	14. A	16	14. A	17	14. A	23
15. C	13	15. A	2	15. C	15	15. A	20
16. D	14	16. C	17	16. A	30	16. A	25
17.		17. C	14	17. C	18	17. A	28
18.		18.		18. D	27	18. D	27
19.		19.		19. A	19	19. A	26
20.		20.		20. D	28	20. B	27
21.		21.		21. D	27	21. D	23
22.		22.		22. D	22	22. D	23
23.		23.		23. D	23	23. D	25
24.		24.		24.		24. C	20

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	2	16	7	52	5	123	7	179
B	0	0	1	10	0	0	1	27
C	11	183	6	138	7	156	5	135
D	3	42	3	30	11	293	11	278

HYPOTHESIS: 7=1. (Effect; $X \cdot Y^L$, Y^S & y)
A=B=C=D, A+D=C+B

TIME OF DAY:
I: 3:40 PM
II:
III: 1:57 PM
IV:

CHAMBER XI
TYPE: MULTIPLE CHOICE

MATING TYPE:	MALE	x	FEMALE
A	7		7
B	7		1
C	1		7
D	1		1

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y+}	Y	
7	$X \cdot Y^L_y$	Y^S	

I

MATING TYPE	ELAPSED TIME m
1. D	22
2. D	22
3. C	24
4. D	25
5. C	26
6. C	31
7. A	29
8. A	28
9. D	30
10. C	28
11. C	42
12. A	27
13. D	30
14. C	29
15. A	30
16. A	16
17. D	29
18. B	24
19. A	52
20. B	41
21. A	19
22. D	16
23. A	11
24. D	17

Continued in II

	Σ	Σ
A		
B		
C		
D		

II

MATING TYPE	ELAPSED TIME m
1. C	33
2. D	25
3. D	16
4. D	15
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	8	213
B	2	65
C	7	213
D	11	247

III

MATING TYPE	ELAPSED TIME m
1. C	25
2. A	19
3. C	31
4. A	25
5. C	32
6. C	30
7. A	24
8. C	29
9. A	29
10. C	2
11. A	29
12. D	19
13. C	20
14. D	27
15. D	27
16. D	29
17. C	14
18. A	14
19. C	12
20. B	28
21. D	29
22. D	11
23. D	45
24. C	8

continued in IV

	Σ	Σ
A		
B		
C		
D		

IV

MATING TYPE	ELAPSED TIME m
1. D	22
2. D	27
3. D	30
4. D	30
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	6	140
B	1	28
C	10	203
D	11	296

HYPOTHESIS: 7=1 (Effect; $X \cdot Y^L$, Y^S & y)

A=B=C=D; A+D=B+C

TIME OF DAY:
I: 6:00 PM
II: 5:54 PM
III: 3:45 PM
IV: _____

CHAMBER XI

TYPE: MULTIPLE CHOICE

MATING TYPE: MALE 7 x FEMALE 7

STOCK GENOTYPE
X Y AUTOSOME

1 $X y^+ Y$

7 $X \cdot Y^L y Y^S$

	MALE	FEMALE
B	7	1
C	1	7
D	1	1

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. D	15	1. C	46	1. A	32	1. D	33
2. D	20	2. C	46	2. C	35	2. D	35
3. D	32	3. D	45	3. C	40	3.	
4. C	15	4. C	44	4. C	55	4.	
5. D	22	5. A	30	5. C	54	5.	
6. D	58	6. A	54	6. D	15	6.	
7. D	31	7. D	30	7. C	29	7.	
8. D	30	8. C	20	8. A	24	8.	
9. D	43	9. A	28	9. A	47	9.	
10. A	25	10. C	18	10. B	25	10.	
11. C	42	11. C	26	11. A	29	11.	
12. A	34	12. A	16	12. C	34	12.	
13. A	23	13. C	16	13. B	28	13.	
14. A	23	14. A	14	14. B	30	14.	
15. A	48	15. D	22	15. D	22	15.	
16. D	33	16. D	33	16. B	38	16.	
17. A	23	17. B	27	17. D	25	17.	
18. D	40	18. D	19	18. A	4	18.	
19. D	10	19. D	13	19. B	27	19.	
20. A	9	20.		20. C	5	20.	
21. A	16	21.		21. A	25	21.	
22. A	17	22.		22. C	33	22.	
23. A	17	23.		23. D	37	23.	
24. D	30	24.		24. D	34	24.	
25. D	1			continued in IV			

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	10	235	5	142			6	161
B	0	0	1	27			5	148
C	2	57	7	216			8	285
D	13	365	6	162			7	201

HYPOTHESIS: 8 = 3 (Effect $X \cdot Y^L$; Y^S INTERACTION) TIME OF DAY:

A=B=C=D; A+D = B+C

I: 2:15 PM

II: 10:56 AM

III: 5:37 PM

IV: 4:45 pm

CHAMBER ~~XII~~ MATING MALE x FEMALE

TYPE: MULTIPLE CHOICE TYPE: A 8 0

STOCK	GENOTYPE X	Y	AUTOSOME			
				B	8	3
3	X_y	y	spa pol	C	3	8
8	$X \cdot Y^L_y$	Y^S	spa pol	D	3	3

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	18	1. D	8	1. C	29	1. C	30
2. D	28	2. B	19	2. D	33	2. D	24
3. D	20	3. A	5	3. A	22	3. D	28
4. C	67	4. A	14	4. B	26	4. D	23
5. D	13	5. B	29	5. A	18	5. D	24
6. C	19	6. D	20	6. B	26	6. C	24
7. D	10	7. A	11	7. A	14	7. A	20
8. C	8	8. D	14	8. D	31	8. D	33
9. A	11	9. D	21	9. A	19	9. D	15
10. C	8	10. A	43	10. D	27	10. D	31
11. C	23	11. B	19	11. D	25	11. A	20
12. C	8	12. A	13	12. B	23	12. D	5
13. B	14	13. C	26	13. A	23	13. B	21
14. D	5	14. D	28	14. D	19	14. C	33
15. A	14	15.		15. C	26	15. C	18
16. C	24	16.		16. A	13	16. D	23
17.		17.		17. A	26	17. D	25
18.		18.		18. D	36	18. C	26
19.		19.		19. B	23	19. C	28
20.		20.		20. A	24	20. C	21
21.		21.		21. C	22	21. C	29
22.		22.		22. B	24	22. D	26
23.		23.		23.		23. C	14
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	2	25	5	86	8	159	2	40
B	2	32	3	67	5	122	1	21
C	4	157	1	26	3	77	9	223
D	5	76	5	91	6	171	11	257

HYPOTHESIS: $\delta = \varsigma$ (effect: $X \cdot Y^L$, Y^S interaction)

A = B = C = D ; A + D = B + C

CHAMBER 12 TYPE: Multiple Choice

MATING TYPE: A ♂ x ♀

TIME OF DAY:
I: 5:36 PM
II: 12:27 PM
III: 3:37 PM
IV: 4:03 PM

INDIVIDUAL GENOTYPE

	X	Y	AUTOSOME		♂	♀
♂	$X \cdot Y^L_{,y}$	Y^S	polert sparkling	B	♂	♀
♀	$X_{,y}$	Y	polert sparkling	C	♂	♂
				D	♀	♀

I		II		III		IV	
MATING TYPE	ELAPSED TIME m.	MATING TYPE	ELAPSED TIME m.	MATING TYPE	ELAPSED TIME m.	MATING TYPE	ELAPSED TIME m.
1. B	24	1. B	30	1. A	27	1. B	27
2. B	27	2. A	30	2. A	19	2. B	84
3. B	17	3. A	39	3. A	9	3. B	33
4. A	16	4. A	34	4. D	16	4. B	41
5. B	25	5. A	32	5. C	30	5. B	22
6. B	21	6. B	19	6. B	29	6. D	27
7. B	36	7. A	11	7. D	16	7. B	21
8. A	21	8. D	36	8. B	29	8. C	8
9. B	36	9. B	36	9. A	21	9. A	23
10. A	26	10. C	21	10. B	22	10. B	29
11. B	26	11. B	40	11. A	12	11. D	34
12. A	16	12. A	35	12. A	22	12. A	13
13. A	15	13. D	17	13. D	25	13. C	44
14. A	25	14. A	17	14. C	24	14. B	12
15. D	21	15. A	17	15. A	24	15. A	35
16. D	30	16. C	25	16. A	23	16. C	21
17. A	25	17. B	15	17. A	24	17. C	20
18. B	15	18.		18.		18. A	22
19. C	22	19.		19.		19. B	31
20. A	32	20.		20.		20. A	15
21. A	32	21.		21.		21. A	30
22. A	15	22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	10	223
B	9	227
C	1	22
D	2	51

	Σ	Σ
A	8	215
B	5	140
C	2	46
D	2	53

	Σ	Σ
A	9	181
B	3	78
C	2	64
D	3	57

	Σ	Σ
A	6	138
B	9	250
C	4	93
D	2	61

HYPOTHESIS: 3 = 8 (Effect $X \cdot Y^L$

A=B=C=D; A+D = B+C

CHAMBER ~~XII~~ MATING MALE x FEMALE

TYPE: MULTIPLE CHOICE TYPE: A 8 8

TIME OF DAY:
I: 1:07 PM
II: 1:43 PM
III:
IV:

STOCK	GENOTYPE X	Y	AUTOSOME			
3	X^y	Y	sparkling pdiet	B	8	3
8	$X \cdot Y^L_y$	Y^S	spa pol	C	3	8
				D	3	3

I

MATING TYPE	ELAPSED TIME m
1. A	27
2. D	30
3. D	25
4. A	33
5. C	31
6. A	29
7. D	29
8. D	27
9. B	25
10. C	24
11. A	34
12. D	21
13. C	26
14. C	19
15. C	32
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	4	123
B	1	25
C	5	132
D	5	132

II

MATING TYPE	ELAPSED TIME m
1. D	31
2. C	36
3. D	30
4. D	23
5. C	45
6. C	30
7. D	20
8. D	14
9. A	24
10. A	9
11. D	19
12. D	25
13. D	20
14. C	29
15. A	21
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	3	54
B	0	0
C	4	140
D	8	182

III

MATING TYPE	ELAPSED TIME
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A		
B		
C		
D		

IV

MATING TYPE	ELAPSED TIME
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 7 = 4 (Effect y^4, y^5, y)
A = B = C = D ; A + B = B + C

CHAMBER ~~XIV~~ MATING TYPE: MULTIPLE CHOICE

	MALE	x	FEMALE
A	7		7
B	7		4
C	4		7
D	4		4

TIME OF DAY:
I: 8:32 AM
II: 11:23 AM
III: 2:25 PM
IV: 1:35 PM

STOCK	GENOTYPE X	Y	AUTOSOME
4	$X \cdot y^+$	Y	
7	$X \cdot y^1 y$	y^5	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	12	1. C	27	1. C	14	1. C	18
2. A	13	2. C	19	2. A	21	2. A	14
3. A	16	3. A	16	3. A	13	3. C	17
4. C	10	4. C	16	4. A	22	4. A	29
5. A	5	5. C	18	5. C	4	5. A	15
6. A	14	6. A	18	6. D	19	6. A	16
7. A	21	7. C	12	7. C	16	7. C	14
8. A	17	8. A	25	8. C	18	8. A	14
9. C	10	9. D	12	9. A	6	9. D	19
10. D	13	10. D	20	10. C	14	10. A	15
11. C	5	11. B	22	11. A	13	11. A	21
12. A	9	12. A	12	12. D	18	12. A	42
13. D	19	13. A	20	13. C	25	13. A	13
14. A	9	14. C	15	14. A	28	14. C	19
15. D	19	15. D	28	15. D	25	15. D	16
16. C	7	16. A	18	16. B	18	16. D	11
17. D	15	17. D	14	17. D	15	17. D	13
18. A	19	18. D	23	18. D	12	18.	
19. A	26	19. D	18	19. D	24	19.	
20. D	10	20.		20. D	20	20.	
21. D	21	21.		21. D	16	21.	
22. D	18	22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	10	149
B	0	
C	5	44
D	7	115

	Σ	Σ
A	6	109
B	1	22
C	6	107
D	6	115

	Σ	Σ
A	6	93
B	1	18
C	6	91
D	8	139

	Σ	Σ
A	9	176
B	0	0
C	4	68
D	4	59

HYPOTHESIS: 7=4 (Effect Y^L, Y^S & y)

A=B=C=D; A+D=B+C

CHAMBER ~~XIV~~

TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 10:41 AM
II: 1:19 PM
III: 10:10 AM
IV: 3:18 PM

MATING TYPE: A 7 x 7

STOCK	GENOTYPE X	GENOTYPE Y	AUTOSOME
4	$X \cdot y^+$	Y	
7	$X \cdot Y^L_y$	Y^S	

	MALE	FEMALE
B	7	4
C	4	7
D	4	4

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	16	1. C	20	1. A	16	1. C	24
2. A	17	2. C	15	2. C	17	2. C	20
3. C	24	3. D	19	3. A	24	3. A	26
4. A	23	4. A	15	4. D	20	4. C	20
5. D	47	5. A	16	5. C	13	5. A	26
6. C	21	6. A	16	6. A	17	6. A	23
7. A	26	7. D	29	7. D	19	7. D	27
8. C	21	8. A	20	8. C	18	8. A	19
9. A	28	9. A	8	9. A	31	9. C	21
10. A	31	10. A	15	10. D	23	10. C	21
11. C	17	11. D	20	11. D	24	11. D	24
12. C	15	12. D	17	12. A	20	12. A	45
13. A	17	13. D	29	13. D	15	13. A	22
14. A	6	14. D	27	14. C	20	14. D	22
15. D	13	15. D	20	15. D	22	15. D	22
16. D	8	16. D	19	16. D	19	16. D	23
17.		17. D	15	17. D	18	17. D	17
18.		18. D	17	18. D	32	18. D	24
19.		19.		19. D	20	19. D	28
20.		20.		20.		20. D	15
21.		21.		21.		21. A	18
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	8	164
B	0	0
C	6	98
D	3	68

	Σ	Σ
A	6	90
B	0	0
C	2	35
D	10	212

	Σ	Σ
A	5	108
B	0	0
C	4	68
D	10	212

	Σ	Σ
A	7	179
B	0	0
C	5	106
D	9	202

HYPOTHESIS: 7=4 (Effect Y^L, Y^S & y)
A = B = C = D; A + D = B + C

TIME OF DAY:
I: 1:52 PM
II: 2:03 PM
III: 12:23 PM
IV: 5:30 PM

CHAMBER ~~XIV~~ MATING MALE x FEMALE
TYPE: MULTIPLE CHOICE TYPE: A 7 7

STOCK	GENOTYPE X	Y	AUTOSOME			
				B	7	4
4	X^{y+}	Y		C	4	7
7	$X^{Y^L}_{y}$	Y^S		D	4	4

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	23	1. A	28	1. B	5	1. A	32
2. D	19	2. A	22	2. A	20	2. C	11
3. A	30	3. C	25	3. C	19	3. A	19
4. C	19	4. A	29	4. A	27	4. A	28
5. A	30	5. D	25	5. C	24	5. A	27
6. A	24	6. D	30	6. C	25	6. C	20
7. C	17	7. A	15	7. A	22	7. C	20
8. A	18	8. A	22	8. A	24	8. C	17
9. D	22	9. C	25	9. A	24	9. C	31
10. D	25	10. A	22	10. B	12	10. D	15
11. A	22	11. A	34	11. A	22	11. A	24
12. A	19	12. D	19	12. C	22	12. A	20
13. D	12	13. C	22	13. D	28	13.	
14. D	20	14. D	29	14. D	19	14.	
15. A	22	15. D	19	15. D	17	15.	
16. D	17	16. D	36	16. D	23	16.	
17. C	16	17.		17. A	24	17.	
18. D	20	18.		18. D	17	18.	
19. D	15	19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	7	165	7	172	7	163	6	150
B	0	0	0		2	17	0	0
C	4	75	3	72	4	90	5	99
D	8	150	6	158	5	98	1	15

HYPOTHESIS: 4=4 (Effect Y^L, Y^S & y)
A=B=C=D A+D=B+C

CHAMBER XIV
TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 2:00 PM
II:
III:
IV:

	MATING TYPE:	MALE	x	FEMALE
	A	7		7
	B	7		4
	C	4		7
	D	4		4

STOCK	GENOTYPE X	Y	AUTOSOME
4	X·y+	Y	
7	X·Y^Ly	Y^S	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	27	1.		1.		1.	
2. D	26	2.		2.		2.	
3. A	19	3.		3.		3.	
4. A	24	4.		4.		4.	
5. A	21	5.		5.		5.	
6. A	26	6.		6.		6.	
7. A	47	7.		7.		7.	
8. C	22	8.		8.		8.	
9. D	22	9.		9.		9.	
10. C	30	10.		10.		10.	
11. A	42	11.		11.		11.	
12. D	15	12.		12.		12.	
13. D	14	13.		13.		13.	
14. B	36	14.		14.		14.	
15. C	31	15.		15.		15.	
16. C	17	16.		16.		16.	
17. D	30	17.		17.		17.	
18. A	3	18.		18.		18.	
19. A	30	19.		19.		19.	
20. A	9	20.		20.		20.	
21. D	32	21.		21.		21.	
22. A	34	22.		22.		22.	
23. D	21	23.		23.		23.	
24. D	15	24.		24.		24.	

	Σ	Σ
A	10	265
B	1	36
C	5	127
D	8	175

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 1=9 (Effect $X \cdot Y^L$, Y^S)

A=B=C=D A+D=B+C

CHAMBER XV

TYPE: MULTIPLE CHOICE

MATING TYPE: A — MALE 9 x FEMALE 9

B — MALE 9 x FEMALE 1

C — MALE 1 x FEMALE 9

D — MALE 1 x FEMALE 1

TIME OF DAY:
I: 6:05 PM
II: 4:07 PM
III:
IV: 4:15 PM

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y+}	Y	
9	$X \cdot Y^L_y$	Y^S_{y+}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. D	22	1. D	13	1. D	23	1. D	24
2. C	25	2. D	29	2. B	15	2. D	30
3. A	28	3. B	20	3. D	15	3. D	25
4. D	29	4. C	20	4. D	15	4. B	21
5. C	47	5. C	19	5.		5. D	38
6. D	17	6. D	35	6.		6. D	28
7. C	25	7. D	30	7.		7. D	28
8. D	37	8. A	15	8.		8. D	31
9. B	18	9. A	30	9.		9. D	28
10. B	17	10. C	26	10.		10. D	28
11. A	22	11. A	30	11.		11. D	18
12. D	26	12. C	24	12.		12. A	25
13. D	22	13. B	13	13.		13. C	25
14. D	26	14. D	15	14.		14. C	14
15. C	5	15. C	15	15.		15. D	1
16. D	23	16. C	15	16.		16. C	19
17. C	15	17. D	8	17.		17.	
18.		18. B	20	18.		18.	
19.		19. C	16	19.		19.	
20.		20. D	14	20.		20.	
21.		21. D	17	21.		21.	
22.		22. D	14	22.		22.	
23.		23. B	14	23.		23.	
24.		24. D	27	24.		24.	

continued in III

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	2	50			3	75	1	25
B	2	36			5	82	1	81
C	5	117			7	135	3	58
D	8	202			13	255	11	279

HYPOTHESIS: 1 = 9 (Effect $X \cdot Y^{L}, Y^{S}$)

A = B = C = D A + D = B + C

CHAMBER ~~XV~~ MATING TYPE: MULTIPLE CHOICE

	MALE	x	FEMALE
A	9		9
B	9		1
C	1		9
D	1		1

TIME OF DAY:
I: 3:25
II:
III:
IV:

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y+}	Y	
9	$X \cdot Y^{L}_{y}$	Y^{S}_{y+}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	17	1.		1.		1.	
2. D	22	2.		2.		2.	
3. A	20	3.		3.		3.	
4. D	11	4.		4.		4.	
5. B	20	5.		5.		5.	
6. B	26	6.		6.		6.	
7. C	26	7.		7.		7.	
8. D	9	8.		8.		8.	
9. D	17	9.		9.		9.	
10. C	30	10.		10.		10.	
11. A	20	11.		11.		11.	
12. D	25	12.		12.		12.	
13. A	13	13.		13.		13.	
14. C	35	14.		14.		14.	
15. C	35	15.		15.		15.	
16. D	15	16.		16.		16.	
17. D	15	17.		17.		17.	
18. D	15	18.		18.		18.	
19. B	15	19.		19.		19.	
20. D	15	20.		20.		20.	
21. B	15	21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	4	70
B	4	76
C	4	126
D	9	144

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 4=9 (Effect Y^l, Y^s)

A=B=C=D; A+D=B+C

CHAMBER XVI

TYPE: MULTIPLE CHOICE

TIME OF DAY:
I: 4:56 PM
II: 6:53 PM
III: 11:16 AM
IV: 4:39 PM

	MATING TYPE:	MALE	x	FEMALE
	A	9		9
	B	9		4
	C	4		9
	D	4		4

STOCK	GENOTYPE X	Y	AUTOSOME
4	$X^{\cdot}_{y+}$	Y	
9	$X^{\cdot}Y^{l}_{y}$	Y^{s}_{y+}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. C	17	1. B	22	1. A	21	1. B	26
2. B	23	2. B	30	2. B	49	2. D	31
3. C	18	3. B	21	3. B	49	3. A	18
4. A	20	4. A	18	4. B	46	4. A	24
5. A	20	5. A	19	5. B	46	5. D	24
6. C	23	6. D	21	6. B	41	6. A	25
7. A	23	7. A	18	7. A	41	7. C	17
8. C	30	8. A	21	8. B	39	8. B	25
9. D	18	9. A	15	9. B	48	9. B	32
10. A	17	10. D	15	10. A	48	10. A	27
11. B	25	11. D	20	11. D	48	11. B	12
12. A	30	12. A	15	12. A	50	12. A	19
13. C	18	13. A	15	13. B	53	13. C	21
14. C	23	14. D	15	14. A	52	14. D	28
15. B	14	15.		15. B	54	15. D	29
16. D	21	16.		16. A	57	16. D	23
17. A	13	17.		17. A	52	17. A	43
18. B	4	18.		18. C	52	18. A	15
19. A	8	19.		19.		19. A	23
20. A	12	20.		20.		20.	
21. B	8	21.		21.		21.	
22. B	15	22.		22.		22.	
23. B	15	23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	8	143	7	121	7	321	8	194
B	7	104	3	73	9	485	4	95
C	6	129	0	0	1	52	2	38
D	2	39	4	71	1	48	5	135

HYPOTHESIS: 4=9 (Effect Y^L, Y^S)
A=B=C=D, A+D=C+B

CHAMBER ~~XVI~~ MATING MALE x FEMALE
TYPE: MULTIPLE CHOICE TYPE: A 9 9

STOCK GENOTYPE
X Y AUTOSOME

4 $X \cdot y+$ Y

9 $X \cdot Y^L_y$ Y^S

B 9 4
C 4 9
D 4 4

TIME OF DAY:
I: 9:27 PM
II: 11:23 AM
III:
IV:

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	30	1. A	31	1.		1.	
2. A	31	2. A	28	2.		2.	
3. A	31	3. C	22	3.		3.	
4. C	24	4. A	37	4.		4.	
5. A	32	5. D	30	5.		5.	
6. D	34	6. B	37	6.		6.	
7. A	57	7. A	26	7.		7.	
8. C	29	8. C	42	8.		8.	
9. D	10	9. B	35	9.		9.	
10. D	34	10. A	33	10.		10.	
11. D	34	11. C	24	11.		11.	
12. B	28	12. B	50	12.		12.	
13. A	22	13. A	23	13.		13.	
14. B	28	14. A	28	14.		14.	
15. D	27	15. A	30	15.		15.	
16. C	12	16. A	49	16.		16.	
17. B	27	17. D	32	17.		17.	
18. D	18	18. A	22	18.		18.	
19. A	38	19. B	15	19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	6	211
B	4	113
C	3	65
D	6	157

	Σ	Σ
A	10	307
B	4	137
C	3	88
D	2	62

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 9=4 (Effect Y^L, y)
A=B

TIME OF DAY:
I: 4:41 PM
II: 5:13 PM
III: 11:30 AM
IV: 4:13 PM

CHAMBER XVIII
TYPE: MALE CHOICE

MATING TYPE: A 9 x 9
B 9 x 4

STOCK GENOTYPE
X Y AUTOSOME

4 $X \cdot y^+ Y$

9 $X \cdot Y^L_y \; Y^S_{y^+}$

C # of A matings per 1st 12 matings

D # of B matings per 1st 12 matings

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	21	1. A		1. A	22	1. B	15
2. B	20	2. A		2. A	19	2. A	22
3. A	24	3. A		3. B	34	3. A	23
4. A	22	4. A		4. A	22	4. B	5
5. A	21	5. A		5. A	29	5. A	23
6. A	27	6. B		6. A	22	6. A	20
7. A	28	7. A		7. A	31	7. B	5
8. A	19	8. A		8. B	22	8. A	29
9. A	26	9. B		9. A	27	9. A	28
10. B	15	10. A		10. B	28	10. B	28
11. B	21	11. A		11. A	27	11. B	30
12. A	23	12. A		12. B	24	12. A	21
13. A	24	13.		13. B	40	13. B	26
14. B	29	14.		14. B	20	14. A	25
15. A	26	15.		15. A	38	15. B	12
16. B	32	16.		16. B	27	16. B	32
17. B	17	17.		17. B	23	17. A	20
18. B	12	18.		18. A	18	18. B	36
19. B	18	19.		19. A	22	19. B	27
20. B	20	20.		20. B	16	20. B	18
21. B	12	21.		21. B	26	21. B	28
22.		22.		22. B	23	22. A	24
23.		23.		23. B	15	23. B	21
24.		24.		24. A	15	24. A	22
						25. B	13
						26. B	2
	Σ Σ		Σ Σ		Σ Σ		Σ Σ
A	11 261	A		A	12 292	A	11 256
B	10 196	B		B	12 298	B	15 298
C	9 211	C	10	C	8 199	C	7 165
D	3 56	D	2	D	4 108	D	5 83

HYPOTHESIS: $9=4$ (Effect Y^L & y)
$A=B$

TIME OF DAY:
I: 11:45 AM
II: 5:45 PM
III: 2:37 PM
IV:

CHAMBER ~~XVIII~~
TYPE: MALE CHOICE

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	9	9
B	9	4
C		
D		

STOCK — GENOTYPE: X, Y, AUTOSOME

4 — $X \cdot y^+$ — Y

9 — $X \cdot Y^L y$ — $Y^S_{y^+}$

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	39	1. A	21	1. A	116	1.	
2. A	28	2. B	19	2. A	21	2.	
3. A	15	3. A	22	3. A	41	3.	
4. A	28	4. A	16	4. B	26	4.	
5. A	14	5. A	22	5. A	16	5.	
6. A	28	6. A	22	6. A	26	6.	
7. B	7	7. A	21	7. B	35	7.	
8. B	21	8. B	25	8. A	16	8.	
9. B	31	9. B	25	9. B	25	9.	
10. A	21	10. B	23	10. B	25	10.	
11. B	15	11. B	23	11. A	11	11.	
12. B	15	12. A	8	12. A	29	12.	
13. B		13. A	20	13. B	18	13.	
14. A		14. A	20	14. B	29	14.	
15. A		15. B	15	15. B	5	15.	
16. B		16. B	30	16. B	26	16.	
17. B		17. A	23	17. A	21	17.	
18. A		18. A	21	18.		18.	
19. A		19. A	24	19.		19.	
20. B		20. B	27	20.		20.	
21. B		21. B	29	21.		21.	
22. B		22.		22.		22.	
23. B		23.		23.		23.	
24. A		24.		24.		24.	
25. A							

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	12		12	240	9	297		
B	13		9	216	8	189		
C	6	134	7	132	8	276		
D	6	128	5	115	4	111		

HYPOTHESIS: 4=9 (Effect Y^L & y)
A = B

TIME OF DAY:
I: 5:48 PM
II: 11:00 AM
III: 6:58 PM
IV: 12:20 PM

CHAMBER ~~XIX~~
TYPE: MALE CHOICE

MATING TYPE: A 4 x 9
B 4 4

STOCK GENOTYPE
X Y AUTOSOME
4 $X \cdot y+$ Y
9 $X \cdot Y^L y$ $Y^S y+$

C # of A matings per 1st 12 matings
D # of B matings per 1st 12 matings

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	15	1. A	22	1. A	20	1. B	20
2. A	18	2. A	23	2. A	14	2. A	41
3. A	20	3. A	25	3. A	21	3. A	29
4. A	21	4. A	21	4. A	20	4. B	20
5. A	20	5. A	26	5. B	28	5. A	21
6.		6. B	22	6. A	14	6. B	21
7.		7. B	28	7. A	26	7. B	22
8.		8. A	22	8. B	24	8. A	23
9.		9. B	20	9. B	33	9. A	43
10.		10. A	21	10. A	23	10. A	35
11.		11. A	18	11. B	23	11. B	34
12.		12. A	22	12. A	23	12. A	23
13.		13. B	27	13. A	22	13. A	22
14.		14. A	21	14. A	6	14. B	24
15.		15. A	37	15. A	5	15. B	24
16.		16. B	28	16. B	15	16. B	32
17.		17. B	27	17. A	27	17. A	17
18.		18. B	40	18. B	15	18. A	17
19.		19. B	17	19. B	15	19. B	10
20.		20. A	23	20.		20. B	12
21.		21. B	27	21.		21. A	12
22.		22.		22.		22. B	48
23.		23.		23.		23. A	20
24.		24.		24.		24. B	18

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	5	74	12	281	12	221	12	303
B	0	0	9	236	7	153	12	285
C	5	74	9	200	8	161	7	215
D	0	0	3	70	4	108	5	117

HYPOTHESIS: 4=9 (Effect Y^L ; y)
A=B

TIME OF DAY:
I: 11:10 AM
II: 6:00 PM
III:
IV:

CHAMBER ~~XIX~~
TYPE: MALE CHOICE

MATING TYPE: A 4 x 9
B 4 x 4

STOCK GENOTYPE
X Y AUTOSOME

4 $X \cdot y^+$ Y

9 $X \cdot Y^L_y$ $Y^S_{y^+}$

C # of A matings per 1st 12 matings

D # of B matings per 1st 12 matings

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	21	1. A	16	1.		1.	
2. B	25	2. A	16	2.		2.	
3. B	33	3. A	16	3.		3.	
4. A	30	4. A	20	4.		4.	
5. A	21	5. B	20	5.		5.	
6. A	15	6. A	22	6.		6.	
7. B	20	7. B	31	7.		7.	
8. A	7	8. A	18	8.		8.	
9. A	21	9. A	18	9.		9.	
10. A	21	10. A	19	10.		10.	
11. B	21	11. A	19	11.		11.	
12. B	20	12. A	21	12.		12.	
13. A	17	13. B	11	13.		13.	
14. A	2	14. B	15	14.		14.	
15. B	2	15. B	25	15.		15.	
16. B	2	16. B	8	16.		16.	
17. A	15	17. B	30	17.		17.	
18. B	15	18. A	20	18.		18.	
19. B	15	19. B	23	19.		19.	
20. B	15	20. B	23	20.		20.	
21. A	15	21. B	15	21.		21.	
22.		22. A	13	22.		22.	
23.		23. B	20	23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	10	164
B	11	189
C	6	115
D	6	140

	Σ	Σ
A	12	218
B	11	221
C	10	185
D	2	51

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 7=9 (Effect: selection for no discrimination of y+ in inbred flies

CHAMBER ~~XX~~

TYPE: FEMALE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
7	$X \cdot Y^{L}_{y}$	Y^{δ}	
9	$X \cdot Y^{L}_{y}$	Y^{δ}_{y+}	

MATING TYPE	MALE	x	FEMALE
A	7		9//7
B	9		9//7
C			
D			

TIME OF DAY:
I: 11:20 AM
II: 3:58 PM
III: 3:54 PM
IV: 4:02 PM

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. B	3	1. A	17	1. B	27	1. A	24
2. B	22	2. A	35	2. A	27	2. B	29
3. B	25	3. B	25	3. B	17	3. B	15
4. A	20	4. B	19	4. A	27	4. A	22
5. B	29	5. A	30	5. B	20	5. A	43
6. B	19	6. B	24	6. A	27	6. B	26
7. A	26	7. B	30	7. B	24	7. A	25
8. A	27	8. B	20	8. A	20	8. A	25
9. B	27	9. A	28	9. B	27	9. B	26
10. B	28	10. B	33	10. B	25	10. A	21
11. B	20	11. B	34	11. A	24	11. B	22
12. B	25	12. A	20	12. B	29	12. B	19
13. A	18	13. A	30	13. B	22	13. B	35
14. B	17	14. A	27	14. A	19	14. B	13
15. A	7	15. A	27	15. B	18	15. B	20
16. B	29	16. A	22	16. A	27	16. B	24
17. B	19	17. A	26	17. B	29	17. A	24
18. A	20	18. B	16	18. B	23	18. A	24
19. A	12	19. B	22	19. B	20	19. A	18
20. B	16	20. B	17	20. A	4	20. A	25
21. A	15	21. B	30	21. A	42	21. B	23
22. A	1	22. A	26	22.		22. B	26
23.		23. A	17	23.		23.	
24.		24. B	16	24.		24.	
		25. B	10				

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	9	146	12	305	9	217	10	251
B	13	279	13	296	12	281	12	278
C								
D								

HYPOTHESIS: 7=9 (Effect, selection for y^+ non-discrimination with imbred stock.

TIME OF DAY:
I: 3:17 PM
II: 3:34 PM
III: 1:25 PM
IV: 1:27 PM

CHAMBER XXJ

TYPE: FEMALE CHOICE

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	9117	7119
B	7119	7119
C		
D		

STOCK	GENOTYPE X	Y	AUTOSOME
7	$X \cdot Y^L_y$	Y^δ	
9	$X \cdot Y^L_y$	$Y^\delta_{y^+}$	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	20	1. A	21	1. B	22	1. B	28
2. B	18	2. B	27	2. B	20	2. B	28
3. B	16	3. A	24	3. B	21	3. A	25
4. B	29	4. A	23	4. B	21	4. B	22
5. A	26	5. B	19	5. A	20	5. B	18
6. B	29	6. B	23	6. B	40	6. A	20
7. B	25	7. B	23	7. B	21	7. A	26
8. A	25	8. B	19	8. A	23	8. B	28
9. B	22	9. A	18	9. B	25	9. B	23
10. A	27	10. B	19	10. B	24	10. B	33
11. A	15	11. A	16	11. A	20	11. A	33
12. A	16	12. B	27	12. A	15	12. A	30
13. A	21	13. A	19	13. A	22	13. A	26
14. A	24	14. A	23	14. B	24	14. B	24
15. A	16	15. A	23	15. A	25	15. B	17
16. B	24	16. A	26	16. B	18	16. A	16
17. A	23	17. A	5	17. A	26	17. A	20
18. A	26	18. B	15	18. B	20	18. B	25
19. B	24	19. B	20	19. A	15	19. B	24
20. B	22	20. A	7	20.		20. A	40
21. A	18	21.		21.		21. A	26
22. B	29	22.		22.		22. B	15
23. A	23	23.		23.		23. B	5
24. B	25	24.		24.		24. A	12
						25. B	15

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	12	260	11	205	8	166	11	274
B	12	283	9	192	11	256	14	305
C								
D								

HYPOTHESIS: 7=9 (Effect selection for no discrimination based on y^+, in imbred stock.

TIME OF DAY:
I: 2:26 PM
II: 2:10 PM
III:
IV:

CHAMBER XX

TYPE: FEMALE CHOICE

MATING TYPE	MALE	x	FEMALE
A	9//7		7//9
B	4//9		7//9
C			
D			

STOCK	GENOTYPE X	Y	AUTOSOME
7	$X \cdot Y^l y$	Y^δ	
9	$X \cdot Y^l y$	Y^δ_{y+}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	30	1. A	21	1.		1.	
2. A	25	2. B	21	2.		2.	
3. B	26	3. B	21	3.		3.	
4. B	26	4. B	21	4.		4.	
5. B	23	5. A	26	5.		5.	
6. A	25	6. B	21	6.		6.	
7. B	26	7. A	19	7.		7.	
8. A	28	8. B	30	8.		8.	
9. A	23	9. B	21	9.		9.	
10. A	23	10. B	28	10.		10.	
11. B	19	11. A	24	11.		11.	
12. B	24	12. B	24	12.		12.	
13. B	18	13. B	29	13.		13.	
14. A	21	14. B	37	14.		14.	
15. A	15	15.		15.		15.	
16. A	8	16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	9	198	4	90				
B	7	162	10	253				
C								
D								

HYPOTHESIS: 7=9 (Effect selection for no discrimination of y+ among inbred flies)

CHAMBER ~~XXII~~ 9

TYPE: FEMALE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
7	$X \cdot Y^{L}_{y}$	Y^{S}	
9	$X \cdot Y^{L}_{y}$	Y^{S}_{y+}	

MATING TYPE: A 9/7 x 7

B 7/9 x 7

C ___ x ___

D ___ x ___

TIME OF DAY:

I: 11:43 AM

II: 3:41 PM

III: 4:04 PM

IV: 4:13 PM

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	23	1. A	16	1. B	20	1. B	27
2. B	38	2. B	24	2. A	20	2. B	17
3. A	19	3. B	21	3. A	28	3. B	32
4. A	27	4. B	22	4. B	30	4. A	25
5. B	26	5. B	23	5. B	22	5. B	23
6. B	26	6. A	23	6. B	9	6. A	22
7. A	15	7. B	19	7. B	26	7. B	19
8. B	22	8. B	27	8. B	10	8. B	19
9. A	21	9. A	23	9. B	32	9. A	17
10. A	22	10. B	22	10. A	27	10. A	32
11. B	26	11. B	20	11. A	20	11. A	20
12. A	24	12. A	14	12. A	24	12. B	21
13. B	23	13. A	20	13. A	24	13. B	21
14. A	21	14. B	20	14. A	23	14. A	27
15. A	23	15. B	7	15. B	19	15. B	9
16. B	25	16. B	19	16. A	19	16. B	18
17. B	22	17. A	23	17. A	21	17. A	22
18. B	26	18. A	13	18. B	20	18. A	22
19. A	25	19. A	27	19. B	20	19. B	7
20. B	16	20. A	10	20. B	13	20.	
21. B	20	21. A	17	21. A	27	21.	
22. A	8	22. A	26	22. B	10	22.	
23. A	11	23. B	23	23.		23.	
24. B	26	24. B	8	24.		24.	
25. B	15	25. B	10				
		26. A	11				
	Σ Σ		Σ Σ		Σ Σ		Σ Σ
A	12 239	A	12 223	A	10 231	A	8 187
B	13 301	B	14 265	B	12 233	B	11 213
C		C		C		C	
D		D		D		D	

HYPOTHESIS: 7=9 (Effect selection for no discrimination of y^+ in inbred flies)

TIME OF DAY: I: 6:42 PM II: ____ III: ____ IV: ____

CHAMBER ~~XXII~~ MATING TYPE: FEMALE CHOICE

	MALE	x	FEMALE
A	9/14		7
B	9/17		7
C			
D			

STOCK GENOTYPE
X Y AUTOSOME

7 $X \cdot Y^L_y$ Y^S

9 $X \cdot Y^L_y$ Y^S_{y+}

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	35	1.		1.		1.	
2. A	20	2.		2.		2.	
3. A	20	3.		3.		3.	
4. B	22	4.		4.		4.	
5. A	20	5.		5.		5.	
6. B	19	6.		6.		6.	
7. A	9	7.		7.		7.	
8. B	7	8.		8.		8.	
9. B	11	9.		9.		9.	
10. A	25	10.		10.		10.	
11. B	12	11.		11.		11.	
12. B	5	12.		12.		12.	
13. B	12	13.		13.		13.	
14. B	16	14.		14.		14.	
15.		15.		15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	5	94						
B	9	139						
C								
D								

HYPOTHESIS: 4=7 (Effect, Dominance-Recessive relationship of Xy vs X·Y^{L}y and interactions with ♂ GENOTYPE

TIME OF DAY:
I: 12:42 PM
II: 7:33 PM
III: 2:00 PM
IV: 12:41 PM

CHAMBER ~~XXIII~~ a

TYPE: FEMALE CHOICE

MATING TYPE	MALE	x	FEMALE
A	7		4//7
B	4		4//7
C			
D			

STOCK	GENOTYPE X	Y	AUTOSOME
4	X·y^{+}	Y	
7	X·Y^{L}y	Y^{S}	

	I		II		III		IV	
	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1.	B	26	B	20	B	34	A	25
2.	B	24	B	13	A	48	A	62
3.	A	36	A	22	A	32	A	62
4.	B	31	B	18	A	50	B	55
5.	B	28	A	32	B	43	B	51
6.	B	24	B	25	B	35	A	47
7.	B	28	B	21	B	33	B	30
8.	B	30	B	15	B	12	A	31
9.	A	21	B	15	B	28	A	53
10.	B	24	A	30	B	16	A	45
11.	A	21	B	25	B	18	B	17
12.	B	20	B	15	B	22	A	15
13.	B	18	B	15	B	13		
14.	B	21	A	15	B	22		
15.	B	20			A	17		
16.					B	28		
17.					B	26		
18.					B	29		
19.					A	10		
20.					A	25		
21.					B	24		
22.								
23.								
24.								

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	3	78	4	99	6	383	8	340
B	12	294	10	189	15	182	4	153
C								
D								

HYPOTHESIS: 4=7 (Effect, Dominance-recessive relationship of $X{\cdot}y^{+}$ vs $X{\cdot}Y^{L}y$, and interations with ♂ genotype

CHAMBER XXIII a

TYPE: FEMALE CHOICE

TIME OF DAY: I: 10:48 AM II: ____ III: ____ IV: ____

	MATING TYPE:	MALE	x	FEMALE
	A	7		4 // 7
	B	4		4 // 7
	C			
	D			

STOCK	GENOTYPE X	Y	AUTOSOME
4	$X{\cdot}y$	Y	
7	$X{\cdot}Y^{L}_{y}$	Y^{S}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	17	1.		1.		1.	
2. B	22	2.		2.		2.	
3. B	23	3.		3.		3.	
4. A	33	4.		4.		4.	
5. B	16	5.		5.		5.	
6. B	12	6.		6.		6.	
7. B	16	7.		7.		7.	
8. B	6	8.		8.		8.	
9. B	26	9.		9.		9.	
10. B	6	10.		10.		10.	
11. B	21	11.		11.		11.	
12. B	32	12.		12.		12.	
13. B	29	13.		13.		13.	
14. A	23	14.		14.		14.	
15. B	22	15.		15.		15.	
16. B	17	16.		16.		16.	
17. B	24	17.		17.		17.	
18. B	30	18.		18.		18.	
19. B	25	19.		19.		19.	
20. B	9	20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	2	353
B	18	56
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 4=7 (Effect, Dominance-Recessive Relationship of $X \cdot y_t$ vs $X \cdot Y^L_y$, and interactions with ♂ genotype

CHAMBER XXIII b

TYPE: FEMALE CHOICE

TIME OF DAY:
I: 5:02 PM
II: 4:40 PM
III: 12:20 PM
IV: 3:30 PM

	MATING TYPE:	MALE	x	FEMALE
	A	4 // 7		4 // 7
	B	7 // 4		4 // 7
	C			
	D			

STOCK GENOTYPE

	X	Y	AUTOSOME
4	$X \cdot y_t$	Y	
7	$X \cdot Y^L_y$	Y^S	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	25	1. A	11	1. A	48	1. A	28
2. A	23	2. A	19	2. A	20	2. A	21
3. A	23	3. B	26	3. A	20	3. A	35
4. A	18	4. A	20	4. A	49	4. A	21
5. A	15	5. A	21	5. A	17	5. A	28
6. A	25	6. A	16	6. A	24	6. A	36
7. A	17	7. A	11	7. A	16	7. A	9
8. A	17	8. A	7	8. A	43	8. A	25
9. A	21	9. B	10	9. A	32	9. A	19
10. A	20	10. A	15	10. A	20	10. A	10
11. A	17	11. A	14	11. A	32	11. A	7
12. A	20	12. A	16	12. A	32	12. A	5
13. A	14	13. A	15	13. A	25	13. A	56
14. A	15	14. A	23	14. A	15	14. A	22
15.		15. A	25	15. A	29	15.	
16.		16. A	19	16. A	33	16.	
17.		17. A	23	17. A	26	17.	
18.		18. A	14	18. A	15	18.	
19.		19. A	15	19. A	15	19.	
20.		20. A	18	20. A	15	20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	14	270	18	302	20	526	14	322
B	0	0	2	36	0	0	0	0
C								
D								

HYPOTHESIS: 8=3 (Effect, Dominance-recessive relationship X^{y} vs $X \cdot Y^{L}y$, and interation with ♂ genotype

CHAMBER XXII a

TYPE: FEMALE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
3	X^{y}	Y	spa pol
8	$X \cdot Y^{L}y$	Y^{S}	spa pol

MATING TYPE: MALE x FEMALE

A: 8 x 3118

B: 3 x 3118

C: ____ x ____

D: ____ x ____

TIME OF DAY:

I: 1:14 PM

II: 3:25 PM

III: 11:40 AM

IV: 9:50 AM

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	24	1. A	23	1. B	27	1. A	20
2. A	23	2. A	27	2. A	29	2. B	30
3. A	23	3. A	31	3. A	20	3. A	42
4. A	17	4. A	34	4. B	37	4. B	30
5. A	30	5. B	28	5. B	37	5. B	41
6. A	22	6. A	34	6. A	28	6. B	28
7. B	22	7. A	49	7. B	48	7. A	13
8. A	27	8. B	17	8. A	31	8. B	38
9. A	16	9. B	17	9. B	15	9. B	25
10. A	26	10. A	23	10. B	40	10. B	14
11. A	21	11. A	25	11. A	15	11. A	56
12. A	18	12. A	16	12. A	28	12. A	55
13. A	11	13. B	19	13. A	28	13. A	30
14. B	22	14. A	25	14. A	38	14. A	20
15. A	39	15. A	25	15. A	25	15. A	45
16. A	18	16. B	15	16. A	34	16. B	30
17. A	28	17. A	25	17. A	15	17. A	25
18. B	16	18. A	21	18. ___	___	18. B	23
19. A	17	19. A	22	19. ___	___	19. B	31
20. A	18	20. A	30	20. ___	___	20. A	25
21. A	23	21. B	25	21. ___	___	21. ___	___
22. ___	___	22. B	16	22. ___	___	22. ___	___
23. ___	___	23. A	28	23. ___	___	23. ___	___
24. ___	___	24. ___	___	24. ___	___	24. ___	___

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	18	401	16	438	11	291	10	330
B	3	60	7	137	6	204	10	290
C	___	___	___	___	___	___	___	___
D	___	___	___	___	___	___	___	___

HYPOTHESIS: 8=3 (Effect; Dominance - Recessive Relationship of X^y vs $X^{\cdot}Y^{L}y$ and interaction with σ^{Genotype}

CHAMBER XXIV a + b

TYPE: FEMALE CHOICE

MATING TYPE: A 8 x 3118

B 3 x 3118

C 3118 x 3118

D 8113 x 3118

TIME OF DAY:
Type I: 4:30 PM
II: 4:28 PM
III: 4:59 PM
IV: 8:19 PM

STOCK GENOTYPE

	X	Y	AUTOSOME
3	X^y	Y	spa^{pol}
8	$X^{\cdot}Y^{L}y$	Y^{S}	spa^{pol}

I a

	MATING TYPE	ELAPSED TIME
1.	A	18
2.	A	21
3.	A	21
4.	A	25
5.	B	25
6.	A	22
7.	A	28
8.	A	28
9.	A	16
10.	A	10
11.	A	19
12.	B	19
13.	A	19
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	11	227
B	2	44
C		
D		

II a

	MATING TYPE	ELAPSED TIME
1.	B	30
2.	A	17
3.	A	22
4.	A	19
5.	B	16
6.	A	16
7.	B	25
8.	B	14
9.	A	18
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	5	92
B	4	85
C		
D		

III b

	MATING TYPE	ELAPSED TIME
1.	D	23
2.	D	25
3.	D	18
4.	D	33
5.	C	24
6.	D	24
7.	D	21
8.	D	12
9.	D	19
10.	D	25
11.	D	19
12.	D	22
13.	C	20
14.	D	25
15.	D	24
16.	D	7
17.	D	18
18.	D	20
19.	D	38
20.	D	15
21.		
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	2	44
D	18	388

IV b

	MATING TYPE	ELAPSED TIME
1.	D	17
2.	D	25
3.	D	26
4.	D	24
5.	C	13
6.	D	38
7.	D	34
8.	D	25
9.	D	29
10.	C	33
11.	D	50
12.	D	32
13.	D	38
14.	D	29
15.	D	22
16.	D	29
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	2	46
D	14	418

HYPOTHESIS: 8=3 (Effect, Dominance-recessive Relationship of Xy and X·Y^{L}y, and interaction with ♂ GENOTYPE

CHAMBER ~~XXII~~ b

TYPE: FEMALE CHOICE

TIME OF DAY:
I: 1:10 PM
II: 3:30 PM
III: 5:34 PM
IV: 8:35 PM

MATING: MALE x FEMALE

STOCK	GENOTYPE X	Y	AUTOSOME		MALE	FEMALE
				A		
				B		
3	X_y	Y	spa^{pol}	C	3118	3118
8	$X \cdot Y^{L}_{y}$	Y^{S}	spa^{pol}	D	8113	3118

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	20	1. D	14	1. C	16	1. C	35
2. C	24	2. C	23	2. D	25	2. C	35
3. D	21	3. D	27	3. C	24	3. D	28
4. D	19	4. C	27	4. D	27	4. D	28
5. D	16	5. D	38	5. D	4	5. D	35
6. D	12	6. C	20	6. D	15	6. D	32
7. D	36	7. D	36	7. D	30	7. C	32
8. D	32	8. D	30	8. D	25	8. D	12
9. D	19	9. D	30	9. D	29	9. C	23
10. C	23	10. D	18	10. C	28	10. D	15
11. D	21	11. D	26	11. D	36	11. D	34
12. C	18	12. D	20	12. D	31	12. D	15
13. D	19	13. D	18	13. C	38	13. D	33
14. D	40	14. C	20	14. D	25	14. D	18
15. C	25	15. D	21	15.		15.	
16. D	24	16. D	23	16.		16.	
17. D	22	17. C	15	17.		17.	
18. D	20	18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A								
B								
C	5	110	5	105	4	106	4	125
D	13	301	12	301	10	247	10	250

HYPOTHESIS: 7=2 (Effect, DOMINANCE-RECESSIVE RELATIONSHIP of $X y^+$ vs $X \cdot Y^1 y$ AND INTERACTION WITH ♂ GENOTYPE

TIME OF DAY:
I: 4:34 PM
II: 3:47 PM
III: 2:00 PM
IV: 12:00 PM

CHAMBER XXV a MATING TYPE: FEMALE CHOICE

	MALE	x	FEMALE
TYPE: A	7		2//7
B	2		2//7
C			
D			

STOCK GENOTYPE

	X	Y	AUTOSOME
2	Xy^+	Y	spa pol
7	$X \cdot Y^1 y$	Y^B	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	32	1. B	28	1. B	51	1. B	38
2. A	23	2. B	22	2. B	20	2. B	38
3. B	45	3. B	44	3. B	35	3. B	25
4. A	30	4. B	55	4. B	35	4. B	40
5. A	27	5. A	26	5. B	31	5. A	30
6. A	27	6. A	26	6. B	35	6. B	48
7. B	39	7. A	41	7. A	23	7. B	30
8. B	36	8. A	41	8. B	43	8. B	28
9. B	34	9. A	23	9. B	35	9. B	37
10. A	37	10. B	36	10. B	28	10. B	30
11. A	25	11. A	40	11. B	26	11. B	25
12. B	30	12. B	38	12. B	27	12. B	40
13. B	32	13. B	20	13. B	17	13. A	26
14. B	55	14. B	47	14. B	48	14. B	35
15. A	31	15. B	26	15. A	25	15. B	18
16. B	28	16. B	21	16. A	44	16. A	26
17. A	28	17. A	17	17. B	26	17. B	35
18. A	26	18. B	19	18. B	43	18. B	35
19. B	33	19. B	17	19. B	27	19. B	27
20. B	25	20. B	20	20. B	17	20. B	3
21.		21. B	28	21. A	30	21. B	31
22.		22. B	21	22. B	31	22. B	7
23.		23. B	9	23. B	30	23. B	16
24.		24. B	20	24. B	10	24. B	15
						25. B	15

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	10	286	7	214	4	122	3	89
B	10	357	17	471	20	615	22	616
C								
D								

HYPOTHESIS: 4=2 (Effect; DOMINANCE - RECESSIVE RELATION-SHIP of X_{y^+} vs $X \cdot Y^L_y$ AND INTERACTION WITH ♂ GENOTYPE

CHAMBER ~~XXV~~ a

TYPE: FEMALE CHOICE

MATING TYPE: A 4 x 2117

B 2 x 2114

C ___ x ___

D ___ x ___

TIME OF DAY:
I: 1:24 PM
II: 11:09 AM
III: 10:33 AM
IV: 9:55 AM.

STOCK GENOTYPE

	X	Y	AUTOSOME
2	X_{y^+}	Y	apu pol
4	$X \cdot Y^L_y$	Y^S	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	25	1. B	29	1. B	41	1. B	32
2. B	20	2. B	29	2. B	42	2. B	32
3. B	29	3. B	20	3. B	32	3. A	27
4. B	31	4. B	20	4. B	47	4. B	27
5. A	23	5. B	24	5. B	55	5. B	30
6. B	31	6. B	38	6. B	40	6. A	23
7. A	23	7. A	18	7. B	35	7. B	46
8. B	31	8. B	24	8. B	40	8. B	32
9. B	55	9. B	19	9. B	50	9. A	32
10. B	31	10. B	19	10. B	40	10. B	24
11. B	23	11. B	29	11. B	35	11. B	24
12. B	23	12. B	13	12. B	33	12. B	37
13. B	23	13. A	13	13. A	18	13. B	37
14. B	35	14. B	24	14. A	28	14. B	48
15. B	18	15. B	17	15. A	30	15. A	5
16. B	26	16. B	27	16. A	25	16. B	18
17. B	20	17. A	24	17. B	35	17. B	62
18. B	20	18. B	33	18. B	35	18. B	30
19. B	29	19. B	19	19. B	15	19. B	24
20. B	26	20. B	30	20. B	35	20. B	23
21. A	19	21. B	15	21. B	30	21. B	17
22. B	34	22. ___	___	22. B	5	22. B	44
23. B	23	23. ___	___	23. B	25	23. B	15
24. ___	___	24. ___	___	24. B	60	24. ___	___
				25. B	15		
				26. B	15		

	Σ	Σ
A	3	65
B	20	556
C	___	___
D	___	___

	Σ	Σ
A	3	55
B	18	429
C	___	___
D	___	___

	Σ	Σ
A	4	101
B	22	760
C	___	___
D	___	___

	Σ	Σ
A	4	87
B	19	592
C	___	___
D	___	___

HYPOTHESIS: 2=7 (Effect Dominance-Recessive Relationship of X^{y+} vs $X{\cdot}Y^{l}y$ AND INTERACTION WITH ♂ GENOTYPE

TIME OF DAY: I: 3:30 II: 4:02 III: 3:47 IV: 2:46

CHAMBER XXV b. MATING MALE x FEMALE

TYPE: FEMALE CHOICE TYPE: D

STOCK	GENOTYPE X	Y	AUTOSOME			
2	X^{y+}	Y	ppa pol	C		
7	$X{\cdot}Y^{l}y$	Y^{δ}		B	2117	2117
				A	7112	2117

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	25	1. B	8	1. B	20	1. B	35
2. B	17	2. B	16	2. B	23	2. B	33
3. B	22	3. B	18	3. B	30	3. B	32
4. B	43	4. B	26	4. B	20	4. B	44
5. B	22	5. B	18	5. B	20	5. B	25
6. B	17	6. B	17	6. B	35	6. B	28
7. B	42	7. B	24	7. B	21	7. B	27
8. B	21	8. A	40	8. B	24	8. B	23
9. A	26	9. A	19	9. B	24	9. A	25
10. B	26	10. B	23	10. B	18	10. B	26
11. B	22	11. B	18	11. B	21	11. B	42
12. B	21	12. B	12	12. A	20	12. B	23
13. B	22	13. A	18	13. A	25	13. B	30
14. A	20	14. A	21	14. B	17	14. B	25
15. A	18	15. B	20	15. A	17	15. B	35
16. A	18	16. A	17	16. B	20	16. A	34
17. B	16	17. B	12	17. A	15	17. B	27
18. B	17	18. B	9	18. B	19	18. B	31
19. B	15	19. A	16	19. B	20	19. B	27
20. B	18	20. B	19	20. B	19	20. B	15
21. B	27	21. B	7	21. B	19	21.	
22. B	15	22. B	15	22. B	25	22.	
23.		23. B	19	23. B	16	23.	
24.		24. B	19	24.		24.	
		25. B	27				

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	4	82	6	131	4	77	2	59
B	18	408	19	327	19	411	18	528
C								
D								

HYPOTHESIS: 2=7 (Effect, DOMINANCE - RECESSIVE RELATIONSHIP of X_{y+} vs $X \cdot Y^{L}_{y}$ and INTERATIONS WITH σ^{7} GENOTYPE

CHAMBER ~~XXV~~ 6 ♂

TYPE: FEMALE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
2	X_{y+}	Y	spa pol
7	$X \cdot Y^{L}_{y}$	Y^{S}	

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A		
B		
C	2117	2117
D	7112	2117

TIME OF DAY:

I: 3:49

II: 3:23

III:

IV:

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	24	1. C	26	1.		1.	
2. C	27	2. C	31	2.		2.	
3. C	51	3. C	27	3.		3.	
4. C	26	4. C	27	4.		4.	
5. C	32	5. C	25	5.		5.	
6. C	38	6. C	33	6.		6.	
7. C	31	7. D	27	7.		7.	
8. C	36	8. D	20	8.		8.	
9. C	36	9. D	37	9.		9.	
10. C	34	10. C	17	10.		10.	
11. C	33	11. C	26	11.		11.	
12. D	31	12. C	24	12.		12.	
13. C	31	13. D	26	13.		13.	
14. C	24	14. D	29	14.		14.	
15. D	28	15. C	26	15.		15.	
16. C	22	16. D	20	16.		16.	
17. C	24	17. D	21	17.		17.	
18. C	37	18. C	25	18.		18.	
19. C	37	19. C	21	19.		19.	
20. C	25	20. C	20	20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A								
B								
C	18	568	13	328				
D	2	59	4	180				

HYPOTHESIS: 7=1 (Effect Dominance - recessive Rel. alionship of X_{y+} and $X \cdot Y^{l}{}_{y}$ and INTERACTION WITH

CHAMBER ~~XXVI~~ a

TYPE: FEMALE CHOICE

TIME OF DAY:
I: 7:37 PM
II: 2:09 PM
III: 12:27 PM
IV: 4:42 PM

	MATING TYPE:	MALE	x	FEMALE
	A	7		1117
	B	1		1117
	C			
	D			

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y+}	Y	
7	$X \cdot Y^{l}{}_{y}$	Y^{B}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	33	1. B	31	1. B	11	1. B	39
2. B	24	2. B	48	2. B	33	2. B	30
3. B	21	3. B	48	3. B	36	3. B	36
4. B	30	4. B	32	4. B	25	4. B	34
5. A	30	5. B	48	5. B	33	5. B	44
6. B	25	6. B	32	6. B	33	6. B	71
7. B	28	7. B	48	7. B	20	7. B	34
8. B	27	8. B	27	8. B	21	8. A	27
9. A	22	9. B	16	9. B	17	9. B	39
10. B	13	10. B	28	10. A	24	10. B	35
11. A	27	11. B	32	11. B	31	11. B	42
12. A	16	12. B	35	12. B	27	12. B	27
13. B	22	13. B	16	13. B	1	13. B	37
14. B	22	14. B	21	14. B	16	14. B	27
15. B	18	15. B	32	15. B	18	15. B	52
16. B	28	16.		16. B	40	16.	
17. B	28	17.		17. B	11	17.	
18. B	27	18.		18.		18.	
19. A	30	19.		19.		19.	
20. B	17	20.		20.		20.	
21. A	15	21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	6	140	0	0	1	24	1	27
B	15	363	15	494	16	373	14	547
C								
D								

HYPOTHESIS: 4=1 (Effect, Dominance-Recessive Relationship of X_{y+} vs. $X{\cdot}Y^{1}_{y}$, and Interaction with ♂ Genotype

CHAMBER ~~XXVI~~ 2+b

TYPE: Female Choice

TIME OF DAY:
I: 12:13 PM
II: 1:44 PM
III: 2:26 PM
IV: 3:07 PM

	MATING TYPE:	MALE	x	FEMALE
	A	4		1117
	B	1		1117
	C	1114		1117
	D	7117		1117

STOCK	GENOTYPE X	Y	AUTOSOME
1	X_{y+}	Y	
4	$X{\cdot}Y^{1}_{y}$	Y^{B}	

Ia

	MATING TYPE	ELAPSED TIME
1.	D	30
2.	B	36
3.	B	35
4.	B	29
5.	B	35
6.	B	35
7.	B	35
8.	A	34
9.	B	30
10.	B	40
11.	B	24
12.	B	34
13.	A	85
14.	B	29
15.	B	28
16.	B	24
17.	B	15
18.	B	15
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	2	59
B	16	474
C		
D		

IIa

	MATING TYPE	ELAPSED TIME
1.	A	14
2.	B	32
3.	B	55
4.	B	26
5.	B	25
6.	B	25
7.	B	24
8.	B	47
9.	A	24
10.	B	41
11.	B	17
12.	B	27
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		
21.		
22.		
23.		
24.		

	Σ	Σ
A	2	38
B	10	319
C		
D		

IIIb

	MATING TYPE	ELAPSED TIME
1.	C	27
2.	D	1
3.	C	23
4.	D	24
5.	C	15
6.	C	29
7.	D	22
8.	C	32
9.	D	23
10.	D	26
11.	C	28
12.	D	28
13.	D	26
14.	C	23
15.	D	39
16.	C	21
17.	C	42
18.	D	18
19.	C	41
20.	C	4
21.	D	32
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	11	285
D	10	239

IVb

	MATING TYPE	ELAPSED TIME
1.	C	40
2.	C	37
3.	C	32
4.	D	22
5.	D	20
6.	C	27
7.	C	46
8.	D	27
9.	D	26
10.	D	21
11.	D	25
12.	D	26
13.	C	24
14.	D	40
15.	C	38
16.	D	23
17.	D	18
18.	D	24
19.	C	24
20.	C	28
21.	C	21
22.		
23.		
24.		

	Σ	Σ
A		
B		
C	10	317
D	11	272

HYPOTHESIS: 4=1 (Effect: DOMINANCE-RECESSIVE RELATION-SHIP of X_{y+} vs $X \cdot Y^{l}_{y}$, AND INTERACTIONS WITH ♂ GENOTYPE

TIME OF DAY: I: 3:33 PM II: 3:36 PM III: 2:53 PM IV: 3:21 PM

CHAMBER ~~XXVI~~ b

MATING TYPE: FEMALE CHOICE

	MALE	x	FEMALE
TYPE: A			
B			
C	1117		1117
D	7111		1117

STOCK GENOTYPE

	X	Y	AUTOSOME
1	X_{y+}	Y	
7	$X \cdot Y^{l}_{y}$	Y^{s}	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	49	1. D	29	1. C	16	1. C	38
2. C	44	2. D	20	2. C	16	2. C	18
3. C	37	3. C	41	3. C	38	3. C	43
4. C	37	4. C	36	4. C	40	4. C	32
5. C	34	5. D	45	5. C	26	5. C	40
6. C	36	6. C	35	6. C	19	6. D	31
7. C	40	7. C	25	7. C	31	7. D	38
8. C	31	8. D	25	8. D	25	8. C	46
9. C	32	9. C	37	9. C	37	9. C	38
10. D	30	10. D	24	10. C	22	10. C	46
11. D	34	11. C	33	11. C	36	11. C	25
12. D	42	12. D	21	12. D	17	12. D	31
13. C	34	13. D	28	13. C	37	13. D	39
14. D	35	14. C	25	14. C	12	14. D	40
15. C	28	15. C	25	15. D	17	15. D	42
16. C	28	16. D	37	16. C	27	16. C	49
17. C	46	17. D	15	17. C	26	17. D	38
18. C	43	18.		18. C	21	18. C	40
19. C	26	19.		19. C	7	19. C	24
20. C	38	20.		20. C	20	20. D	20
21. C	37	21.		21. C	28	21.	
22.		22.		22. D	28	22.	
23.		23.		23. D	20	23.	
24.		24.		24. C	45	24.	

	Σ	Σ
A		
B		
C	17	620
D	4	141

	Σ	Σ
A		
B		
C	8	257
D	9	244

	Σ	Σ
A		
B		
C	19	504
D	5	107

	Σ	Σ
A		
B		
C	12	439
D	8	279

HYPOTHESIS: 7=1 (Effect: DOMINANCE-RECESSIVE RELATIONSHIP of X_{y+} vs $X{\cdot}Y^{L}_{y}$, AND INTERACTION WITH ♂ GENOTYPES.

TIME OF DAY: I: 4:42 PM II: 5:50 PM III: _____ IV: _____

CHAMBER ~~XXVI~~ 6. MATING TYPE: FEMALE CHOICE

	MALE	x	FEMALE
TYPE: A	_____		_____
B	_____		_____
C	1117		1117
D	7111		1117

STOCK GENOTYPE

	X	Y	AUTOSOME
1	X_{y+}	Y	
7	$X{\cdot}Y^{L}_{y}$	$Y^{B'}$	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. D	25	1. C	19	1.		1.	
2. C	30	2. C	18	2.		2.	
3. C	29	3. C	41	3.		3.	
4. C	31	4. C	17	4.		4.	
5. C	30	5. C	38	5.		5.	
6. D	29	6. C	35	6.		6.	
7. C	24	7. C	15	7.		7.	
8. D	25	8. C	28	8.		8.	
9. C	30	9. C	37	9.		9.	
10. C	33	10. C	25	10.		10.	
11. C	46	11. C	12	11.		11.	
12. C	38	12. C	26	12.		12.	
13. C	36	13. C	10	13.		13.	
14. C	30	14. C	15	14.		14.	
15. C	30	15. C	15	15.		15.	
16. D	23	16.		16.		16.	
17. D	20	17.		17.		17.	
18. D	21	18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A		
B		
C	12	387
D	6	143

	Σ	Σ
A		
B		
C	15	351
D	0	0

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 9=4 (Effect Dominance-Recessive relationship of $X \cdot y^+ - X \cdot Y^L_y$ and interactions with ♂ genotypes)

CHAMBER XXVII ♂ MATING TYPE: FEMALE CHOICE

	MALE	x	FEMALE
TYPE: A	9		4/9
B	4		4/9
C			
D			

TIME OF DAY:
I: 4:27 PM
II: 10:51 AM
III: 11:44 AM
IV: 4:05 PM

STOCK	GENOTYPE X	Y	AUTOSOME
4	$X \cdot y^+$	Y	
9	$X \cdot Y^L_y$	$Y^{\beta}_{y^+}$	

I		II		III		IV	
MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m	MATING TYPE	ELAPSED TIME m
1. A	25	1. B	15	1. A	22	1. B	21
2. A	15	2. A	15	2. A	36	2. A	20
3. B	16	3. A	16	3. A	31	3. A	21
4. B	18	4. A	15	4. A	17	4. A	20
5. B	30	5. A	15	5. B	8	5. B	20
6. B	25	6. B	86	6. A	13	6. B	21
7.		7. B	13	7. A	13	7. A	11
8.		8. B	26	8. A	32	8. B	15
9.		9. A	24	9. B	8	9. B	30
10.		10. A	25	10. A	19	10. B	28
11.		11. A	15	11. A	25	11. B	15
12.		12. A	20	12. A	20	12. A	19
13.		13.		13. A	9	13.	
14.		14.		14. A	26	14.	
15.		15.		15. A	26	15.	
16.		16.		16. A	13	16.	
17.		17.		17. A	15	17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	2	40
B	4	89
C		
D		

	Σ	Σ
A	8	145
B	4	80
C		
D		

	Σ	Σ
A	15	317
B	2	16
C		
D		

	Σ	Σ
A	5	91
B	7	150
C		
D		

HYPOTHESIS: 9=4 (effect: DOMINANCE - RECESSIVE RELATIONSHIP OF $X \cdot y^+$ VS $X \cdot Y^L$ AND INTERACTION WITH σ^7 GENOTYPE

CHAMBER XXVII b

TYPE: FEMALE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
4	$X \cdot y^+$	Y	
9	$X \cdot Y^L$	$Y^S_{y^+}$	

MATING TYPE: MALE x FEMALE

A ____ ____

B ____ ____

C 4/19 4/19

D 9/4 4/19

TIME OF DAY:

I: 5:20 PM

II: 4:27 PM

III: 12:20 PM

IV: 4:30 PM.

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	27	1. C	22	1. D	25	1. D	29
2. D	25	2. D	25	2. D	33	2. C	41
3. C	25	3. C	15	3. D	28	3. D	26
4. D	25	4.		4. C	25	4. C	22
5. C	24	5.		5. C	20	5. C	33
6. C	24	6.		6. D	20	6. D	26
7. C	25	7.		7. C	10	7.	
8. D	20	8.		8. D	25	8.	
9. C	19	9.		9. D	68	9.	
10. C	26	10.		10. C	22	10.	
11. C	18	11.		11. D	55	11.	
12. C	4	12.		12. C	50	12.	
13.		13.		13. D	50	13.	
14.		14.		14. D	45	14.	
15.		15.		15. C	11	15.	
16.		16.		16. D	11	16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A								
B								
C	9	192	2	37	6	138	3	96
D	3	70	1	25	10	360	3	81

HYPOTHESIS: q=4 (effect: DOMINANCE-RECESSIVE RELATIONSHIP OF $X \cdot y^+$ VS $X \cdot Y^L$ AND INTERACTION WITH ♂ GENOTYPE

TIME OF DAY: I: 1:30 PM II: _____ III: _____ IV: _____

CHAMBER ~~XX~~ VIII B

MATING TYPE: FEMALE CHOICE

STOCK	GENOTYPE X	Y AUTOSOME
4	$X \cdot y^+$	Y
9	$X \cdot Y^L_y$	$Y^S_{y^+}$

MATING TYPE	MALE	x	FEMALE
A	_____		_____
B	_____		_____
C	4119		4119
D	9114		4119

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	23	1.		1.		1.	
2.		2.		2.		2.	
3.		3.		3.		3.	
4.		4.		4.		4.	
5.		5.		5.		5.	
6.		6.		6.		6.	
7.		7.		7.		7.	
8.		8.		8.		8.	
9.		9.		9.		9.	
10.		10.		10.		10.	
11.		11.		11.		11.	
12.		12.		12.		12.	
13.		13.		13.		13.	
14.		14.		14.		14.	
15.		15.		15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	0	
B	0	
C	1	23
D	0	

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: ♂=♀ (effect: ___ discrimination based on yt in: ___ bred stocks

TIME OF DAY:
I: 12:36 PM
II: 2:14 PM
III: 5:03 PM
IV: 11:30 AM

CHAMBER XXVIII

MATING TYPE: FEMALE CHOICE

MATING TYPE	MALE	x	FEMALE
A	7117		7119
	9119		7119
B	7119		7119

STOCK	GENOTYPE X	Y AUTOSOME
♂	$X \cdot Y^{L}_{y}$	Y^{S}
♀	$X \cdot Y^{L}_{y}$	Y^{S}_{y+}

I

MATING TYPE	ELAPSED TIME
1. B	17
2. B	16
3. B	17
4. B	15
5. B	16
6. A	20
7. A	17
8. A	21
9. B	22
10. A	15
11. B	15
12. A	16
13. B	16
14. B	23
15. B	10
16. B	21
17. B	21
18. B	16
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	5	89
B	13	225
C		
D		

II

MATING TYPE	ELAPSED TIME
1. A	19
2. A	51
3. A	40
4. B	23
5. B	26
6. B	30
7. B	50
8. B	29
9. A	26
10. A	23
11. A	21
12. A	24
13. A	24
14. B	19
15. A	9
16. B	21
17. B	27
18. A	15
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	10	252
B	8	225
C		
D		

III

MATING TYPE	ELAPSED TIME
1. B	27
2. B	20
3. B	55
4. B	27
5. B	27
6. B	30
7. B	23
8. A	35
9. A	22
10. B	19
11. B	26
12. A	26
13. A	17
14. B	18
15. A	15
16. A	16
17. A	16
18. B	24
19. B	25
20. B	19
21. B	15
22.	
23.	
24.	

	Σ	Σ
A	7	147
B	14	355
C		
D		

IV

MATING TYPE	ELAPSED TIME
1. A	27
2. B	17
3. A	27
4. A	5
5. B	25
6. A	15
7. B	12
8. B	25
9. B	13
10. B	28
11. B	28
12. A	28
13. A	13
14. A	28
15. B	13
16. B	13
17. B	15
18. B	15
19. B	15
20. B	30
21. A	20
22. A	17
23. A	11
24. B	15
26. A	15

	Σ	Σ
A	11	206
B	14	264
C		
D		

HYPOTHESIS: 1=2 (Effect sparkling polient)
A=B=C=D A+D=B+C

CHAMBER ~~XXIX~~

TYPE: MULTIPLE CHOICE

STOCK GENOTYPE
X Y AUTOSOME

1 X_{y+} Y

2 X_{y+} Y spa^{pol}

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	1	1
B	1	2
C	2	1
D	2	2

TIME OF DAY:
I: 1:08 PM
II: 10:23 AM
III: 1:20 PM
IV: 10:36 PM

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. B	31	1. A	38	1. A	23	1. A	43
2. C	24	2. A	40	2. D	23	2. C	24
3. C	13	3. A	35	3. C	29	3. B	32
4. B	25	4. D	31	4. B	28	4. A	40
5. C	26	5. A	34	5. B	22	5. A	34
6. A	28	6. B	34	6. B	21	6. D	24
7. D	23	7. A	43	7. A	20	7. A	30
8. B	22	8. B	39	8. B	19	8. B	34
9. A	23	9. B	34	9. A	18	9. B	17
10. C	28	10. D	28	10. B	50	10. C	27
11. B	22	11. A	39	11. A	26	11. A	39
12. B	31	12. B	42	12. D	21	12. C	30
13. B	28	13. A	19	13. B	35	13. A	32
14. A	24	14. B	32	14. B	20	14. B	30
15. C	29	15. A	32	15. B	13	15. B	27
16. A	25	16. B	20	16. A	21	16. D	23
17. B	32	17. B	17	17. B	25	17. C	24
18. B	26	18. B	22	18. A	19	18. B	31
19. C	15	19. A	9	19. A	26	19. D	26
20. B	28	20. B	35	20. A	13	20. C	29
21. B	24	21. A	35	21. D	30	21. B	30
22. A	15	22. C	30	22. A	30	22. B	19
23. A	19	23. A	28	23. A	25	23. B	16
24.		24.		24. A	2	24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	6	134	11	352	11	217	6	218
B	10	269	9	275	9	233	9	236
C	6	135	1	30	1	29	5	134
D	1	23	2	59	3	74	3	73

HYPOTHESIS: 1=2 (Effect sparkling Polier)
A=B=C=D; A+D=B+C

TIME OF DAY:
I: 4:09 PM
II:
III:
IV:

CHAMBER XXIX
TYPE: MULTIPLE CHOICE

STOCK	GENOTYPE X	GENOTYPE Y	AUTOSOME
1	X_{y+}	Y	
2	X_{y+}	Y	spa pol

MATING TYPE	MALE	x	FEMALE
A	1		1
B	1		2
C	2		1
D	2		2

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. D	32	1.		1.		1.	
2. A	18	2.		2.		2.	
3. B	28	3.		3.		3.	
4. A	30	4.		4.		4.	
5. B	27	5.		5.		5.	
6. A	27	6.		6.		6.	
7. D	40	7.		7.		7.	
8. C	21	8.		8.		8.	
9. D	25	9.		9.		9.	
10. D	26	10.		10.		10.	
11. C	25	11.		11.		11.	
12. B	15	12.		12.		12.	
13. B	27	13.		13.		13.	
14. A	25	14.		14.		14.	
15. C	20	15.		15.		15.	
16. C	27	16.		16.		16.	
17. C	34	17.		17.		17.	
18. C	26	18.		18.		18.	
19. D	42	19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	4	100
B	4	97
C	6	153
D	5	165

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 7=6 (Effect Y^L)

A=B=C=D; A+D=B+C

CHAMBER XXX

TYPE: MULTIPLE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
6	$X \cdot Y^L_y$	Y	
7	$X \cdot Y^L_y$	Y^S	

TIME OF DAY:

I: 4:06 PM

II: 11:30 AM

III: 10:06 AM

IV: 3:35 PM

MATING TYPE	MALE	x	FEMALE
A	7		7
B	7		6
C	6		7
D	6		6

I

MATING TYPE	ELAPSED TIME
1. C	29
2. D	28
3. A	29
4. B	21
5. B	17
6. B	13
7. C	30
8. D	27
9. D	25
10. A	8
11. B	7
12. A	39
13. B	20
14. A	29
15. C	29
16. A	26
17. A	28
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	6	159
B	5	78
C	3	88
D	3	80

II

MATING TYPE	ELAPSED TIME
1. B	39
2. C	39
3. B	24
4. A	19
5. C	34
6. C	34
7. A	41
8. A	41
9. D	53
10. C	30
11. A	30
12. C	30
13. B	36
14. A	28
15. B	28
16. D	20
17. B	35
18. B	20
19. C	37
20. A	37
21. B	27
22. A	10
23. A	11
24. B	35

	Σ	Σ
A	8	217
B	8	244
C	6	204
D	2	73

III

MATING TYPE	ELAPSED TIME
1. A	39
2. B	32
3. B	19
4. B	39
5. A	19
6. B	45
7. B	35
8. B	14
9. A	14
10. A	5
11. B	20
12. C	27
13. C	36
14. D	11
15. B	25
16. B	30
17. A	1
18. A	45
19. B	60
20. B	5
21. A	55
22. B	45
23.	
24.	

	Σ	Σ
A	7	178
B	12	369
C	2	63
D	1	11

IV

MATING TYPE	ELAPSED TIME
1. A	30
2. A	25
3. B	22
4. D	22
5. A	22
6. C	31
7. B	14
8. C	32
9. D	24
10. D	11
11. A	45
12. D	12
13. B	14
14. D	27
15. C	10
16. D	10
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	4	122
B	3	50
C	3	73
D	6	106

HYPOTHESIS: 7=6 (Effect Y^L)
A=B=C=D; A+D = B+C

CHAMBER XXX MATING TYPE: MULTIPLE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
6	X	Y^L_y	Y
7	X	Y^L_y	Y^S

TYPE	MALE	x	FEMALE
A	7		7
B	7		6
C	6		7
D	6		6

TIME OF DAY:
I: 6:28 PM
II: 3:45 PM
III: 12:10 PM
IV:

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	27	1. A	27	1. C	25	1.	
2. A	17	2. B	27	2. A	46	2.	
3. B	24	3. D	24	3. C	15	3.	
4. B	14	4. C	30	4. B	14	4.	
5. D	27	5. A	24	5. A	29	5.	
6. C	23	6. A	23	6. D	24	6.	
7. B	10	7. A	15	7. B	36	7.	
8. C	23	8. A	23	8. A	43	8.	
9. A	10	9. A	15	9. C	46	9.	
10. B	16	10. B	22	10. B	23	10.	
11. B	16	11. A	25	11. A	36	11.	
12. A	13	12.		12. B	15	12.	
13. B	18	13.		13. B	38	13.	
14. D	23	14.		14. A	22	14.	
15. B	24	15.		15. B	25	15.	
16. B	13	16.		16. B	50	16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	4	67	7	152	5	176		
B	8	135	2	49	7	201		
C	2	46	1	30	3	86		
D	2	50	1	24	1	24		

HYPOTHESIS: 7=5 (Effect Y^L, Y^S [T(X-Y)

A=B=C=D A+D=B+C

CHAMBER XXXI

TYPE: MULTIPLE CHOICE

STOCK GENOTYPE

X Y AUTOSOME

5 $X^{\cdot}_{y}$ Y

7 $X^{\cdot}Y^{L}_{y}$ Y^{S}

TIME OF DAY:
I: 6:05 PM
II: 6:15 PM
III: 11:29 AM
IV: 3:00 PM

MATING TYPE	MALE	x	FEMALE
A	7		7
B	7		5
C	5		7
D	5		5

I

MATING TYPE	ELAPSED TIME
1. A	26
2. A	26
3. D	26
4. C	27
5. A	24
6. A	25
7. A	39
8. C	26
9. C	38
10. D	33
11. A	35
12. B	22
13. A	19
14. B	25
15. C	15
16. D	15
17. D	15
18. D	15
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	7	194
B	2	47
C	4	106
D	5	104

II

MATING TYPE	ELAPSED TIME
1. D	20
2. D	18
3. C	21
4. A	26
5. A	23
6. C	23
7. A	32
8. B	19
9. B	28
10. C	17
11. D	23
12. D	23
13. D	12
14. B	24
15. C	19
16. B	19
17. A	20
18. A	27
19. A	23
20. B	16
21. A	14
22.	
23.	
24.	

	Σ	Σ
A	7	165
B	5	106
C	4	80
D	5	96

III

MATING TYPE	ELAPSED TIME
1. A	22
2. C	23
3. A	22
4. A	18
5. C	30
6. A	17
7. B	15
8. D	28
9. B	21
10. A	21
11. D	23
12. B	15
13. B	9
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	5	100
B	4	60
C	2	53
D	2	51

IV

MATING TYPE	ELAPSED TIME
1. A	29
2. A	24
3. A	25
4. C	25
5. A	23
6. A	23
7. C	30
8. B	15
9. A	31
10. A	20
11. C	23
12. C	34
13. B	34
14. B	15
15. B	15
16. B	15
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24.	

	Σ	Σ
A	7	175
B	5	94
C	4	112
D	0	0

HYPOTHESIS: 7=5 (Effect Y^L, Y^S [T(X-Y)])

A=B=C=D; A+D=B+C

CHAMBER XXXI

TYPE: MULTIPLE CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
5	$X^{\cdot}_{y}$	Y	
7	$X^{\cdot}_{y}$	Y^L Y^S	

TIME OF DAY:
I: 4:41 PM
II:
III:
IV:

MATING TYPE	MALE	x	FEMALE
A	7		7
B	7		5
C	5		7
D	5		5

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. A	23	1.		1.		1.	
2. C	23	2.		2.		2.	
3. C	16	3.		3.		3.	
4. C	22	4.		4.		4.	
5. C	17	5.		5.		5.	
6. C	19	6.		6.		6.	
7. A	17	7.		7.		7.	
8. C	21	8.		8.		8.	
9. C	20	9.		9.		9.	
10. A	15	10.		10.		10.	
11. A	23	11.		11.		11.	
12. C	16	12.		12.		12.	
13. A	15	13.		13.		13.	
14.		14.		14.		14.	
15.		15.		15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I		II		III		IV	
	Σ	Σ	Σ	Σ	Σ	Σ	Σ	Σ
A	5	93						
B	0							
C	8	154						
D	0							

HYPOTHESIS: 6=5 (effect Y^L)

A=B=C=D; A+D=B+C

CHAMBER XXXII MATING MALE x FEMALE

TYPE: MULTIPLE CHOICE TYPE: A 6 6

B 6 5

C 5 6

D 5 5

TIME OF DAY:
I: 5:44 PM
II: 11:09 AM
III: 11:20 AM
IV: 3:21 PM

STOCK GENOTYPE

	X	Y	AUTOSOME
5	$X \cdot y$	Y	
6	$X \cdot Y^L_y$	Y	

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	27	1. C	13	1. D	36	1. A	23
2. C	27	2. C	19	2. A	68	2. A	15
3. C	23	3. C	22	3. C	31	3. A	25
4. C	21	4. A	31	4. C	17	4. A	28
5. C	21	5. D	21	5. C	24	5. B	5
6. D	32	6. C	27	6. B	15	6. A	28
7. D	11	7. B	12	7.		7. B	14
8. C	15	8. B	33	8.		8. C	31
9. C	15	9. A	29	9.		9. B	21
10. C	15	10. A	18	10.		10. A	16
11. A	11	11. B	5	11.		11. B	15
12. D	11	12. C	20	12.		12. B	20
13. C	11	13. D	18	13.		13. B	21
14. A	14	14. C	53	14.		14.	
15. D	26	15. D	10	15.		15.	
16. C	14	16. C	25	16.		16.	
17. D	16	17. B	61	17.		17.	
18. D	34	18. C	22	18.		18.	
19. D	30	19. B	47	19.		19.	
20. D	21	20. A	15	20.		20.	
21. D	26	21. C	9	21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	2	25
B	0	0
C	10	189
D	9	207

	Σ	Σ
A	4	93
B	5	158
C	9	210
D	3	49

	Σ	Σ
A	1	68
B	1	15
C	3	72
D	1	36

	Σ	Σ
A	6	135
B	6	96
C	1	31
D	0	0

HYPOTHESIS: 6=5 (effect Y^L)

A=B=C=D A+D=B+C

CHAMBER ~~XXXII~~

TYPE: MULTIPL CHOICE

STOCK GENOTYPE

	X	Y	AUTOSOME
5	$X^{\cdot}_{y}$	Y	
6	$X^{\cdot}_{y}$	Y^L_y	Y

MATING TYPE: MALE x FEMALE

	MALE	FEMALE
A	6	6
B	6	5
C	5	6
D	5	5

TIME OF DAY:

I: 4:55

II:

III:

IV:

I		II		III		IV	
MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME	MATING TYPE	ELAPSED TIME
1. C	23	1.		1.		1.	
2. C	23	2.		2.		2.	
3. A	19	3.		3.		3.	
4. C	20	4.		4.		4.	
5. D	22	5.		5.		5.	
6. D	22	6.		6.		6.	
7. B	25	7.		7.		7.	
8. B	18	8.		8.		8.	
9. D	15	9.		9.		9.	
10. B	9	10.		10.		10.	
11. B	27	11.		11.		11.	
12.		12.		12.		12.	
13.		13.		13.		13.	
14.		14.		14.		14.	
15.		15.		15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	Σ	Σ
A	1	19
B	4	79
C	3	66
D	3	59

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

	Σ	Σ
A		
B		
C		
D		

HYPOTHESIS: 4=5 (effect y)
A=B=C=D; A+D=B+C

CHAMBER ~~XXXIII~~

TYPE: MULTIPLE CHOICE

STOCK	GENOTYPE X	Y	AUTOSOME
4	$X^{\cdot}_{y+}$	Y	
5	$X^{\cdot}_{y}$	Y	

MATING TYPE:	MALE	x	FEMALE
A	4		4
B	4		5
C	5		4
D	5		5

TIME OF DAY:
I: 12:22 PM
II: 5:45 PM
III: 12:43 PM
IV: _____

I MATING TYPE	I ELAPSED TIME	II MATING TYPE	II ELAPSED TIME	III MATING TYPE	III ELAPSED TIME	IV MATING TYPE	IV ELAPSED TIME
1. A	25	1. D	19	1. A	28	1.	
2. D	25	2. D	15	2. A	22	2.	
3. C	21	3. A	22	3. A	22	3.	
4. D	19	4. B	16	4. A	40	4.	
5. B	19	5. D	14	5. C	26	5.	
6. D	20	6. A	30	6. A	15	6.	
7. A	18	7. D	18	7. A	15	7.	
8. B	16	8. A	25	8. A	15	8.	
9. D	20	9. A	21	9. A	15	9.	
10. C	22	10. D	15	10.		10.	
11. A	25	11.		11.		11.	
12. A	17	12.		12.		12.	
13. B	20	13.		13.		13.	
14. D	25	14.		14.		14.	
15.		15.		15.		15.	
16.		16.		16.		16.	
17.		17.		17.		17.	
18.		18.		18.		18.	
19.		19.		19.		19.	
20.		20.		20.		20.	
21.		21.		21.		21.	
22.		22.		22.		22.	
23.		23.		23.		23.	
24.		24.		24.		24.	

	I Σ	I Σ	II Σ	II Σ	III Σ	III Σ	IV Σ	IV Σ
A	4	85	4	93	8	172		
B	3	55	1	16	0	0		
C	2	43	0	0	1	26		
D	5	109	5	81	0	0		